AGRICULTURAL ENGINEERING

Published by the AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Executive Office of the Society: Saint Joseph, Michigan.

SAMUEL P. LYLE, *President* RAYMOND OLNEY, *Secretary-Treasurer*

VOLUME 20 MAY 1939 NUMBER 5

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Published monthly by the American Society of Agricultural Engineers. Publication office at Benton Harbor, Michigan. Editorial and advertising departments at the executive office of the Society, St. Joseph, Michigan . . . . Price $3.00 a year, 30 cents a copy; to members $2.00 a year, 20 cents a copy. Postage to countries to which second-class rates do not apply, $1.00 additional . . . . The Society is not responsible for statements and opinions contained in papers published in this journal; they represent the views of the individuals to whom they are credited and are not binding on the Society as a whole . . . . Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921 . . . .

Tire Use Economy

FARM implement wheel problems are not solved by the mere placing of rubber and air between steel and ground. To enable farmers to make the most of the apparent advantages of pneumatic tires, such tires must be designed to meet clearly defined use requirements, and principles must be developed to guide farmers in the selection and use of tires to meet their widely varying operating conditions.

Tread profile, wear, tire diameter, pressure carried, weight on wheels, drawbar load, and tractive surface influence wheel slippage, rolling resistance, side slip, operating gear, fuel and labor economy, working capacity, and quality and timeliness of work done. Initial investment, ability of traction tires to withstand tractive loads, tread wear, possibility and cost of retreading, auxiliary tractive equipment, adaptability of worn traction tires to non-tractive uses, interchangeability of tires on drawn equipment, hours of use per year, fuel and labor costs, influence on maintenance and depreciation costs of wheeled equipment, influence on gross farm income through quality, quantity, and timeliness of work done, and effect on health, safety, comfort, and mental energy of the operator are all factors in the economic use of tires on farm equipment.

A start has been made in agricultural engineering research toward developing principles of tire application based on these physical, biological, and economic considerations.

AGRICULTURAL ENGINEERING

VOL 20, NO 5 EDITORIALS MAY 1939

Recognition

APPOINTMENT of Deane G. Carter to be dean of the college of agriculture, director of the agricultural experiment station, and director of the agricultural extension service of the University of Arkansas, effective July 1, reflects recognition and credit in several directions.

Mr. Carter has served the State and University of Arkansas since 1922 as professor and head of the agricultural engineering department. His promotion gives due recognition to his growing familiarity with the state and its agricultural problems, his contributions to their solution, and his capacity as an administrator and cooperator. We are confident that time and results will amply justify his selection for this high honor and broadened administrative responsibility.

To the best of our knowledge, Mr. Carter is the first agricultural engineering graduate to be appointed to such high position in public administration. His past achievements and recent recognition are a credit to Iowa State College and its agricultural engineering department, where he earned both his bachelor and master of science degrees in agricultural engineering.

The American Society of Agricultural Engineers is proud that Mr. Carter has been affiliated with it since 1916, the year following his graduation from college. He became a Junior Member in that year, progressed through the Associate Member and Member grades to the grade of Fellow, and has served at different times as chairman of the Farm Structures Division, chairman of the College Division, vice-president and member of the Council, and chairman and member of various committees. We like to think that his contacts and long service in the Society have contributed somewhat to his individual capacity and professional advancement, in return for his generous and valuable contributions of time and thought to the progress of agricultural engineering.

To Mr. Carter, our heartiest congratulations and good wishes. To young agricultural engineers, to the teachers responsible for the development of young agricultural engineers, and to A.S.A.E. members in general, his promotion should prove a great inspiration.

Machine Application Efficiency

LABOR efficiency and power economy studies, as reported in Dr. J. B. Davidson's article in this issue, represent an approach to production efficiency as a broader and more inclusive subject than the thermal, mechanical, and functional efficiency of individual machines.

High individual machine efficiency is prerequisite to high production efficiency, but by no means guarantees it. Engineering effort to further improve farm machinery is commendable, but there is a great deal more to the agricultural engineering job of helping farmers achieve low-cost, high-quality production. Many farmers have modern, well-engineered equipment, but few have a balanced combination of equipment or an operating plan adapted in accordance with known principles of production engineering to make the best use of their acreage, soil, climate, labor, capital, or market situation. Few even have any adequate system of lubrication or maintenance. The Iowa investigations have carried the machine use subject to the point of questioning the merits of time-honored corn growing operations performed by machines, from preparation of the seedbed to harvesting, in search of opportunities to decrease labor and power requirements. This study of machine application efficiency showed not only some profitable short cuts in corn growing, but possibilities for improvement in machine design.

As to the relative opportunities, in the fields of inherent machine efficiency and machine application efficiency, for decreasing the labor requirements of growing corn, Dr. Davidson's report indicates that the 5.13 man-hours per acre for present advanced practice might be reduced to less than 4 man-hours by machine improvements, but that the present advanced practice cuts more than 11 man-hours per acre from the labor requirement for present good practice. This difference is apparently attributable to improved machine application efficiency. If these figures are representative of the situation in other crops and areas, it looks as if farmers may have more to gain at present from research on machine application than from research on machine design. In other words, research in machine application efficiency should logically catch up with and closely follow or parallel research in individual machine efficiency, and make the most of it. Machine application efficiency is inherent machine efficiency put to practical use.

It is natural that in Iowa the study should be applied to corn. In some other areas similar studies have been applied to this and other major crops and combinations of crops. Additional emphasis on this type of study is suggested for consideration on its merits as an opportunity for increasing possible production efficiencies and agricultural engineering usefulness to farmers.

Grass Silage Equipment

IN THE article by Dr. J. W. Bartlett, published in this issue, we find from the pen and viewpoint of a dairy husbandman some apparently sound advice on objectives which agricultural engineers may well keep in mind in their efforts to contribute to farm practice in ensiling grass crops. Dr. Bartlett says, in concluding his paper, "Costs must be kept low. Simple equipment must be adopted in order that the average dairy farmer can harvest his crops without fuss or furore and can be sure that he is going to have good feed for his dairy herd."

We would interpret his reference to "simple equipment" as meaning equipment no more complicated than the combine, for example, and less complicated if possible. It should also be available in such sizes that the farmer with only one or two small silos might own and use it profitably. Larger sizes and more complicated equipment might well be developed for large farms and possibly custom work, where the use factor and labor saving would justify the increased investment.

As compared with the harvesting of field dried hay, the principal factor working against low cost of grass silage is the much greater weight to be loaded, hauled, unloaded, chopped, and elevated. Cost of the preservative and of mixing it with the forage, and of stronger silo construction or reinforcement are additional factors to be considered in

comparison with costs of corn silage. Factors favorable to low cost are low field losses and elimination of drying.

For a setup to do the job at low additional investment cost, these factors seem to indicate possibilities in the adaptation of binders, combines, and hay loaders for mowing and loading, fast hauling by truck or tractor and trailers with capacity closely matched to the cutting rate, dump or slide unloading, hopper or endless belt feeding to the blower, and automatic feeding and mixing of preservative at the blower. The basic equipment should have other uses so far as possible, to share the investment cost.

We are confident that agricultural engineers will come through with equipment adaptations and use methods that will enable average dairy farmers to make legume and grass silage with some measure of saving over former forage costs.

Comfort for Cows

WE HAVE called frequent and encouraging attention to agricultural engineering possibilities in investigating environmental influences on biological production and in developing environmental control structures, equipment, and principles for farm application to secure maximum quality and quantity of production at lowest cost. A constructive step in this direction is being taken by the Farm Structures Division of the American Society of Agricultural Engineers in arranging a session on influences of environment on animal production for the annual meeting at St. Paul in June.

Dairy production is a tremendous enterprise. Any knowledge which might result in even a one per cent reduction in cost or increase in quality would be important. But in designing dairy stables agricultural engineers have had little more to work with, from the standpoint of animal comfort, than the general knowledge that dairy cows do not do well outdoors during blizzards or heat waves. Stables have been designed and built with due consideration for sanitation, working convenience, feed storage, fire resistance, and even architectural beauty. When agricultural engineers have information on the influence per degree of temperature, per cent relative humidity, and cubic foot of air change, above or below optimum points for various breeds and ages of cattle, in terms of gallons of milk or pounds of butterfat, they can begin to correlate this information with farm prices for dairy products, and with construction methods and costs to maintain specified degrees of control. This is the key to the extent of environmental control which can be justified by resulting increased income.

How far this matter of environmental control might be carried is well illustrated by the popular theory that the playing of a radio in the stable increases milk production. The possibilities are intriguing. Entertainment is an art, and stable radio may never progress beyond the point where dairymen send in request numbers on behalf of their herds, or where feed producers, large dairies, or other agricultural interests sponsor the classics, swing bands, or lullaby hours catering to the commercialized maternal instinct of the humble cow. In that case it will be of little agricultural engineering interest.

Sound, however, is a physical phenomenon of matter in motion. It is of wide scientific interest, and its generation, transmission, control, and prevention for human use purposes is an active field of engineering research and application. Its properties of wave length, intensity, and rhythm are measurable, predictable, and controllable in accordance with mathematical and physical laws. If there is any basis of fact for the old saying that "music hath charms to soothe the savage beast," it may also have an influence on domesticated animals and their production worthy of agricultural engineering attention. Sound and production are both in the field of engineering. What pitches, intensities, and rhythms would be most conducive to milk production? What range of variety and frequency of repetition would get the best response? Should the milking machine generate pulsations continuously in waltz time or should they be synchronized with the beat of the music currently playing? Will cows exhibit breed, age, or individual preferences for particular types or pieces of music? If so, individual receiving sets and earphones for each animal are indicated. Will certain pieces be taboo, for example, "The Flight of the Bumblebee," particularly in fly time?

Seriously, the early prospect of agricultural engineering problems in barnyard acoustics suggests that it is high time to determine the influences on dairy production of such primary environmental factors as temperature, humidity, and air movement and to design dairy housing accordingly. The radio can be turned off if its influence is unfavorable, but cows must continuously live in an atmosphere which has temperature, humidity, and movement. If they are to be money makers, the conditions to which they are subjected should be as favorable as their breeding and feeding.

Committee Work

To the Editor:

MY EXPERIENCE as chairman of the Soil and Water Conservation Division of the A.S.A.E. for the last few months has confirmed my earlier opinion that the committee setup in the Society, or at least in that Division, is not satisfactory.

In former years, both as a member and as chairman of different committees of the Division I have had somewhat the following experience. About March 1 the chairman of the committee wakes up to the fact that more than half the Society year is past and that the committee has done nothing. He hurriedly writes each member asking for suggestions for a committee report. By April 1 about half the members have replied, and, if he is lucky, two or three suggest the same problem. He then writes each member again, setting forth the results of his former questionnaire and asking each member to undertake some special phase of the subject suggested by the two or three who did agree. If the subject is one that seems worth the effort, a progress report is hurriedly gotten together for the annual meeting, and the committee is provided with an objective for the following year. If not, the responses are so meager that the chairman simply has no report, and the committee is continued for the next year with the same or different membership and the same program repeated.

As a contrast to this entirely unsatisfactory procedure, some of our committees start the year with a definite program, either as a result of hitting upon a good problem the year before, or, better, because they are appointed for a definite job. Such a committee starts in right after the annual meeting and generally has a worthwhile and well-considered report ready by the following June.

Would it not be desirable to drop all those committees for which there is not an active demand? Certainly there are problems enough in the profession to justify all the committee work that can be successfully carried, if the problems are definitely assigned to committees whose membership is selected with the particular problem in mind.

M. R. LEWIS

Chairman
Soil and Water Conservation Division
American Society of Agricultural Engineers

Hydraulics of Open Ditches

By John G. Sutton

DESIGN of open ditches for flat land drainage cannot be approached arbitrarily as an exact science, and research data are limited. In considering the hydraulics there are many variables, some of which are local in character and require a study of the individual problems under consideration.

Nearly all drainage channels are located in areas having a flat topography, where the inadequate natural drainage makes it necessary to resort to artificial drainage channels in order to utilize the lands. The maximum rate of runoff through such drainage channels is, to a large degree, dependent upon and controlled by the capacity of man-made drainage works. That this is true may be seen by tracing the runoff cycle from a flat drainage system. The first rain saturates the ground. In summer during normally dry periods, this may require even 2 or 3 in of rain. On flat areas a much more favorable condition for absorption of water exists than on lands having even a one per cent slope. When the ground is saturated, surface runoff starts. The rapidity with which the surface water flows from the fields into the nearest surface drain depends principally upon the slope, the surface cover, the character of cultivation, and the amount of storage due to slight irregularities in topography. These are some of the most important factors influencing the rate of runoff from flat lands.

As the rate of runoff increases, ditches fill up until they reach their maximum carrying capacity which, if exceeded, results in overflow. On tile-drained lands, the flow through the tiles probably increases the maximum rate of runoff only in watersheds where they drain sinkholes or ponds that would store water if undrained. However, investigations by Woodward and Nagle appear to indicate that tile drains have little measureable effect upon maximum rates of runoff. The rate of percolation into the soil has a very important effect on the rate of runoff. Ditches vary considerably in depth and overflow occurs first on the lands which lie lowest with respect to the hydraulic gradient of adjacent ditches. When the overflow of large areas of flat land commences, the rate of runoff tends to reach a peak and increases very slowly with additional rainfall.

Runoff from flat lands differs from runoff from hilly or sloping lands in several important respects. On flat lands, the rain has a more favorable opportunity to soak into the ground. Storage on fields before entering drains and storage in low areas due to the drainage channels overflowing upstream from the point of measurement are two distinct processes, both of which are major factors in influencing the measured maximum rate of runoff from flat lands. Ordinarily both storage processes occur during major storms. It should be recognized that storage due to channel overflow is due to lack of capacity of the channel and can be justified only on an economic basis.

On flat lands the maximum rate of runoff depends upon the size of artificial drains, culverts, tiles, openings through bridges, obstructions such as railroad and road fills, and other works and topography which influence the rate of runoff and storage. Throughout the discussion, we should keep in mind that the maximum rate of runoff in major storms depends to a large extent upon the carrying capacity of the composite drainage system which exists at the time of runoff. When the rate of runoff from the watershed exceeds the capacity of the existing drainage system, additional runoff is stored largely on low lying fields.

In falling stages, flow from the drainage system continues at a high rate over a long period of time because of the large amount of storage. Thus the characteristic runoff curve from flat areas is flat. However, the runoff from hilly lands is flashy and the runoff curve reaches sharp peaks. To make the comparison on a numerical basis, in hilly or mountainous areas, flash floods occur where the maximum discharge frequently reaches several hundred second-feet per square mile and sometimes exceeds 1,000 sec-ft per sq mi. On the other hand, in flat lands requiring drainage, the maximum runoff has seldom exceeded 50 sec-ft per sq mi and most open channels rendering adequate drainage have been designed to discharge 15 to 30 sec-ft per sq mi. We will recall that one-inch depth runoff over the watershed for 24 hr is equivalent to 26.88 cfs per sq mi.

Our drainage works have been constructed and reconstructed largely on the basis of experience, and, in some instances, by the method of trial and error. If we are to judge by results, this method has been, to a large degree, satisfactory. There are over 80,000,000 acres of lands in organized drainage enterprises. These enterprises include some of our most valuable agricultural lands in the country, such as the northwest quarter of Ohio, the northern half of Indiana, large areas in eastern and central Illinois, and north central Iowa. On the whole, these lands

Presented before the Soil and Water Conservation Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., December 2, 1938. Mr. Sutton (Mem. A.S.A.E.) is district engineer, Bureau of Agricultural Engineering, U. S. Department of Agriculture.

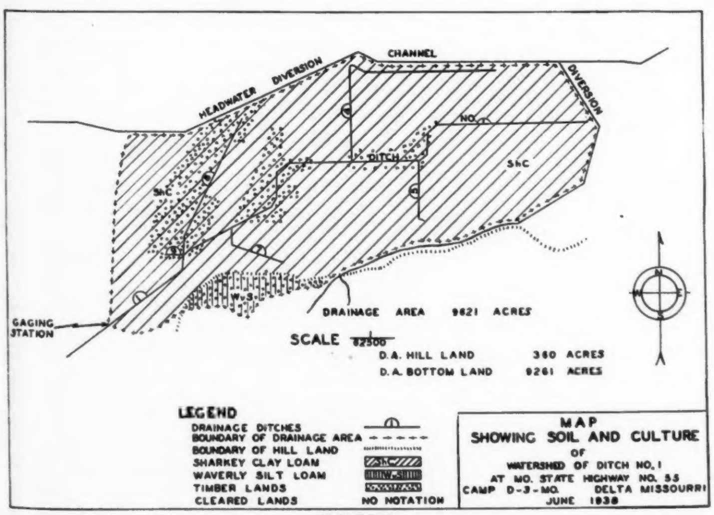

FIGURE 1

are reasonably well drained when the drainage works are properly maintained. When the drainage works depreciate, the effects of poor drainage soon becomes apparent. In developing the drainage systems, numerous empirical curves were prepared from accumulated experience which form a sound basis for construction and rehabilitation of drainage works.

The problem of the design of drainage ditches is not simple. The drainage works of today have been developed by the intensive study of individual problems, considering all hydraulic factors, and it is believed that such intensive study of individual problems by trained and experienced engineers will continue to form the best basis for the design or rehabilitation of important drainage works.

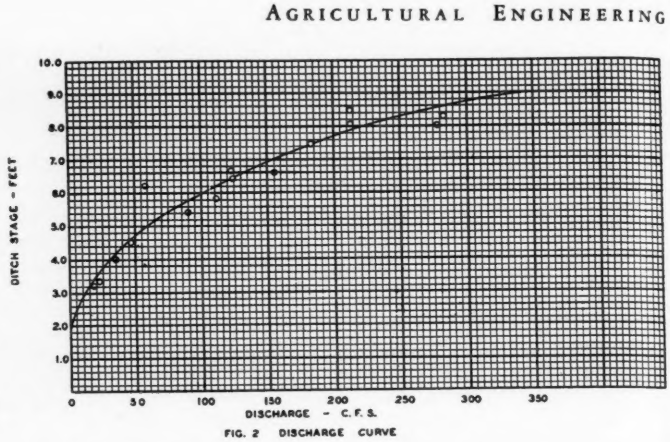

FIG. 2 DISCHARGE CURVE

Since the hydraulics of open drains is complicated by the factors discussed above, I wish to cite a specific example illustrating runoff characteristics from a typical drainage system without tile drainage, to show the character of the runoff and point out the problems met. Fig. 1 shows the sketch of the area lying a few miles southwest of Cape Girardeau, Missouri. The watershed area consists of 9621 acres of land; the soils on the watershed include about 96 per cent Sharkey clay loam and about 4 per cent Waverly silt loam. The area contains 3.7 per cent hill land, but it is thought that the hill area did not appreciably affect the results. The maximum length of the area is 36,960 ft and the maximum width is 15,840 ft. The ditch on which the measurements were made, known locally as Ditch No. 1, is located about in the center and runs the entire length of the area. Five side drains enter Ditch No. 1 above the gaging station, but there are additional shallow farm drains and road drains not shown on the map. The average slope of the land is about 0.4 ft per thousand outside the small area of hill land. In making the study, one automatic rain gage, three standard rain gages, and an automatic water stage recorder were used. Fig. 2 shows the rating curve.

The following tabulation gives the accumulative runoff as compared with the accumulative rainfall during several rains:

Date	Accumulative rainfall	Accumulative runoff	Per cent runoff (Ratio total runoff to total rainfall)
1 – 23 to 1 – 26 (1938)	1.12	0.09	8
1 – 30 to 2 – 1 (1938)	1.25	0.20	18
2 – 14 to 2 – 20 (1938)	2.62	0.95	36
3 – 29 to 4 – 9 (1938)	4.65	2.80	60
6 – 8 to 6 – 27 (1938)	7.00	1.43	20
7 – 17 to 7 – 19 (1938)	2.70	0.07	3
7 – 30 to 8 – 5 (1938)	2.25	0.54	24

It may be seen that the runoff varied from 3 to 60 per cent of the rainfall during the selected periods. This ratio depends largely upon the degree of saturation, the capacity of the ground to absorb water, and the intensity of the rainfall. Specific attention is called to the two extremes—one in the April flood where the per cent runoff amounted to 60 per cent of the rainfall during a storm period, and to the rain in July where only three per cent ran off and no doubt nearly all of the remainder was absorbed by the ground.

The rainfall-runoff chart for the March 29 to April 1 period is reproduced in Fig. 3. The bars represent the hourly runoff. At the start of the rain, March 29, the ground was almost saturated and in no condition to absorb any appreciable amount of water. The runoff reached a peak of 173 cfs some nine hours following the morning rain of March 29 and the ditch had begun to go down when the morning rain of March 30 occurred. This produced a peak of 209.5 cfs, some 7 hr following the rain. The night rain of March 30 caused a peak of 260 cfs, some eleven hours following the rain on the following day. On the chart are shown notations of the estimated quantity of runoff due to previous rains. It is estimated that almost two-thirds of the maximum rate of runoff was not due to the rain occurring eleven hours previously, but some was due to rain occurring over two days previously and some to the morning rain of March 30. These rains caused a considerable overflow throughout the area. This chart does not represent an unusual condition for spring rains and demonstrates the need for taking into consideration rainfall for several days in designing drainage works. Fig. 4 shows the accumulative rainfall and runoff during this flood.

Attention is called to the duration of the successive peaks of approximately ten or eleven hours. This flattening was due to the storage effect in the watershed basin. Another point that should be mentioned is that a high rate of runoff continued for over three days after the last rain of March 30 (Fig. 4). The explanation is that all the tributary ditches were full and water was stored on fields and that runoff continued at a high rate for over three days draining off the stored water.

It is believed that the actual capacity of the drainage channels influenced the maximum rate of runoff to a greater degree than apparent in these graphs. Following the heavy rains, water was stored in fields and low sloughs and did not get to the ditch at the gaging station. Had the area had more complete drainage, a higher rate of runoff would have occurred and the stages of the ditches would have fallen more rapidly.

The Bureau of Agricultural Engineering, through the CCC drainage camps, has collected considerable data relative to the maximum runoff from various watersheds. It is expected that the results will be completely analyzed and discussed in a technical bulletin to be published at a later date. These data should be a useful guide in the design and rehabilitation of drainage enterprises.

A set of curves (Fig. 5) has been prepared as a guide for the CCC drainage camps in the central district in the rehabilitation of drainage enterprises being done under the supervision of the Bureau of Agricultural Engineering. These curves were based on results of studies undertaken by the Bureau through the CCC drainage camps and on representative formulas for flood flow and drainage runoff coefficients. They are also based on flow measurements from typical drainage watersheds giving careful consideration to effectiveness of the drainage. The curves are considered as

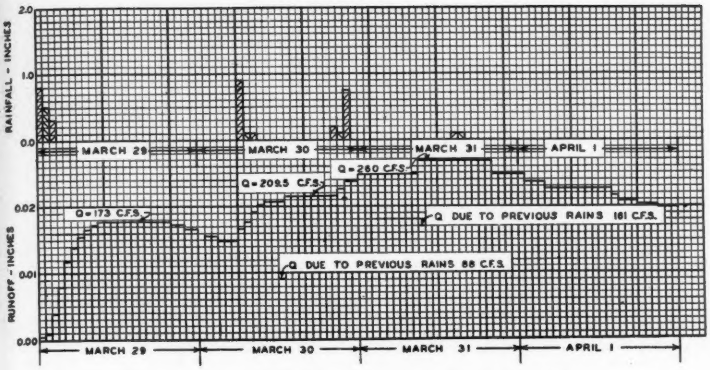

FIG. 3 RAINFALL AND RUNOFF IN INCHES PER HOUR

tentative specifications for carrying out current operations, and they may be changed considerably after a more complete analysis of runoff studies has been completed.

These curves apply only to flat watersheds such as are ordinarily drained by artificial drainage channels. They do not apply to rolling or hilly lands. They should not be used in any specific problem where any substantial part of the watershed area has a maximum slope of more than ten feet per mile, except to estimate the runoff from the flat portion of the watershed area.

Curve A will provide for a rate of runoff from flat lands, which will seldom be exceeded. This curve will provide good overflow protection. It probably will not provide for the maximum flood flows during major floods. It represents approximately the upper enveloping curve of measured runoff from flat watersheds during the highest flows of 1936 and 1937 in the states covered by the camps of the central district. During these two years flood heights exceeded the 1913 flood or other known flood heights in several localities according to statements of residents. Had the capacities of the existing channels been greater or had the watershed contained lands of even moderate slopes, the runoff would, no doubt, have been greater. In design of levees this curve should be used with caution because confining water in narrow channels increases velocities and reduces the time of concentration. It is not to be used in the design of ordinary farm drainage ditches because channels designed on that basis would be so large they would be uneconomical for agricultural drainage. It is believed that this curve will give adequate capacity for drainage structures, such as levees and spillways, where failure would not result in excessive property damage or loss of life and for village drains where good overflow protection is desirable.

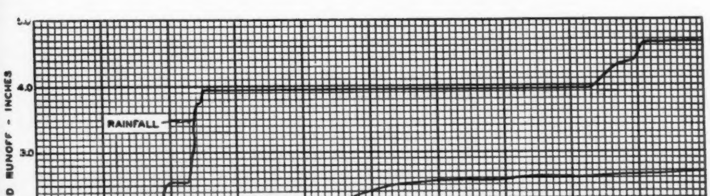

FIG. 4 ACCUMULATIVE RAINFALL AND RUNOFF

The camps were divided in two groups; those in north Ohio, north Indiana, central Illinois, Iowa and north Missouri comprise the northern group; those in southeast Missouri and western Kentucky comprise the southern group. Curve B will provide excellent agricultural drainage in all the states in the central district. This curve should be used in preference to Curve C where frequent overflow will endanger structural improvements such as bridges, roads, and buildings, or damage special crops having high value. Curve B will provide about as good drainage and overflow protection as can be justified economically in agricultural areas. Curve C will provide very good agricultural drainage for the northern group of camps. However, channels designed on the basis of Curve C will be subject to occasional overflow. Curve C may be used to provide good agricultural drainage for the areas of the southern group of camps, but more frequent overflow from rainfall of high intensity is to be expected in the latter areas. It is not advisable to design for a lower rate of runoff than given by Curve C for the area in which the southern group of camps is located.

Curve D provides satisfactory agricultural drainage for the northern group of camps providing overflow will not cause excessive damages. However, ditches based on this curve will be subject to comparatively frequent overflow. Satisfactory drainage is provided only if the ditch is continuously maintained to provide full capacity. If channels designed on a basis of Curve D deteriorate, they will provide inadequate drainage and very poor protection against overflow.

In the judgment of the author, Curve D can be used with somewhat more assurance in Iowa, northern Missouri, western Illinois, than in Ohio, Indiana and eastern Illinois. In the latter states curves B and C should be used on most projects.

What is meant by good protection against overflow as compared with good drainage is well illustrated by a story that was related recently concerning the work of the CCC drainage camp at Defiance, Ohio.

This camp had just completed a ditch in cooperation with the farmers within the drainage enterprise. During and following an extremely heavy rain a group of farmers gathered on the banks of the ditch to see whether or not it would overflow their fields. They watched the water gradually rise to near bank-full stage and then recede without overflowing. These farmers had helped pay for and were securing good overflow protection. Had these farmers been satisfied with a smaller ditch, they probably would have had some of their lower fields overflow for a short period of time, although the damage may have been negligible. Where such overflow does no appreciable damage to crops, the drainage provided may still be termed good agricultural drainage.

The experience to date indicates that, as areas are developed, the people desire good overflow protection from their drainage channels as well as economical drainage. It is believed that this is a paying investment as overflow does result in some damage and may cause depreciation in farm and land values. Therefore, as funds become available, it is believed a worth while invest-

ment to build ditches on a basis of the B curve and secure better overflow protection, as well as excellent drainage. Where funds are not available, it may be necessary to design ditches on the basis of the C and D curves. Attention is again called to the fact that these curves apply only to flat watersheds.

The Bureau has recently conducted additional research to determine the value of *n* in Kutter's formula. Results secured have emphasized the necessity for annual maintenance to maintain the effectiveness of drainage channels. Many interesting and valuable results have been secured and these are in the process of being worked up for publication. Until this analysis has been completed, recommendations prepared by C. E. Ramser, in U.S.D.A. Technical Bulletin No. 129, "Flow of Water in Drainage Ditches", are suggested for use. For convenience, these recommendations are quoted herewith to be used in solving Kutter's formula to obtain flow in ditches; the application of this formula is discussed in several standard texts on hydraulics.

The proper side slopes to use in design of ditches has considerable influence on the hydraulic design. Many of the original drainage ditches were constructed with side slopes steeper than 1 to 1, and with wide bottoms, by means of floating dredges. With the widespread use of draglines, it is a simple construction problem to build ditches having flat side slopes. The CCC drainage camps have constructed a few ditches in the nature of experiments having 2, 2½, and even 3 to 1 side slopes. At first it was difficult to sell the farmers on a slope as flat as 3 to 1. The ditches were seeded and a good sod obtained. After the farmers found that they could utilize the ditch banks for pasture and crops, and improve the maintenance, many nearby farmers also wanted similar ditches constructed.

The use of flat side slopes is distinctly in the experimental stage, and at the present time we must stick to the conservative practice of building ditches which will have stable side slopes. This, of course, depends primarily upon the character of the soil. Cross sections prior to the rehabilitation of the ditch are of considerable value in determining what constitutes a stable slope. A slope of 1½ to 1 is ordinarily stable for ditches in soils having a high percentage of clay particles. In soils which cave, a flatter slope of 2 to 1 or 2½ to 1 is preferable. Sometimes ditches have a good sod covering the banks and it is not desirable to disturb it. In some instances, a bottom cleanout is considered adequate and the side slopes for such channels may be somewhat steeper than 1½ to 1. A berm of 6 to 8 ft between the edge of the spoil bank and the top of the ditch section is an important feature of construction to aid stability of the slopes and to prevent soils from washing in.

The bottom width of the ditch will ordinarily depend upon the size of watershed for the larger ditches. However, for ditches serving small watershed areas, the minimum bottom width may govern design. With the small ⅜ and ½ yard draglines now in common use, it is practical for a capable operator to construct a good ditch having a bottom width of only 3 ft. *(Continued on page 180)*

VALUES OF *n* RECOMMENDED FOR DESIGN

(From U.S.D.A. Technical Bulletin No. 129)

n	Description of channel
0.025	Large channel in rolling country, with high velocity and sufficient low-water flow to prevent rapid growth of vegetation; slick silt lining perimeter; maintenance.
0.030	Large channel in rolling country, with sufficient low-water flow to prevent rapid growth of vegetation; moderate erosion; maintenance.
0.030	Large channel in flat country, with fairly large low-water flow; no appreciable erosion; annual clearing.
0.035	Small channel in rolling country, with small low-water flow; erosion sufficient to cause some irregularities; maintenance.
0.035	Small channel in flat country, with insufficient low-water flow to prevent rapid growth of vegetation in lower part of channel; annual clearing.
0.035	Large channel with high velocity and large low-water flow; rapid erosion causing large irregularities; no vegetation.
0.040	Small channel in flat country with very fertile loamy soil conducive to rapid growth of vegetation; very small low-water flow, or dry in summer; annual clearing.

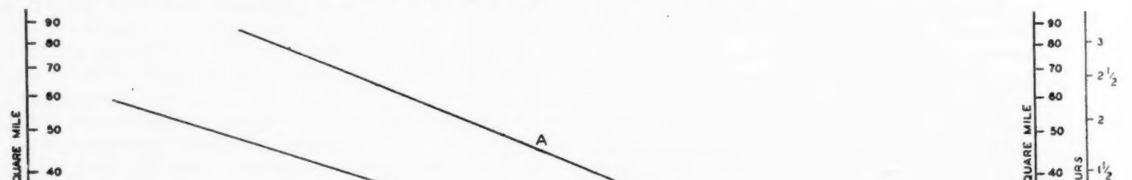

FIG. 5 RUNOFF CURVES, CENTRAL DISTRICT DRAINAGE CAMPS

"A" for good protection from overflow (not maximum flood runoff). "B" for excellent drainage. "C" for very good agricultural drainage in Ohio, Indiana, Illinois, Iowa, and northern Missouri, and for good agricultural drainage in Kentucky and southern Missouri. "D" for fair agricultural drainage in Ohio, Indiana, Illinois, Iowa, and northern Missouri

A Portable Hay Drier

By Wm. Aitkenhead

INTEREST in artificial drying at Purdue University agricultural experiment station began in 1926, a wet year. At that time Director G. I. Christie encouraged the department of agricultural engineering to investigate the possibilities of artificial drying.

First efforts were directed towards drying hay in stacks. These were fairly successful. I had seen such a system in operation at Chester, England, in 1925. Since storing hay in stacks is not common practice in Indiana, the double labor of building the stack and then reloading the dried stack for transport to the barn mitigated against this method. Then there were the operative difficulties of getting the hot air to pass evenly from the center cone through the mass of hay. The tendency was for the hot air to find an easy channel through the hay. This made uniform drying difficult.

The next effort was to produce a portable drier which could be taken to the most convenient location for the job in hand and there positively produce dried hay.

Fig. 1 shows the drier alongside the beef cattle barn at Purdue. Nearly 100 tons of hay from the field were run through the machine in 1938 and over 40 tons of dry hay were stored in the mow.

The machine is in two units, the portable furnace and the drier. Fig. 1 shows the units connected and in operation.

Fig. 2 shows the arrangement of drier and path of the hay through the machine. The hay is moved by a manure spreader angle conveyor driven by the customary ratchet feed, which gives a satisfactory control of the speed of travel. The hay first passes over a perforated bottom and considerable drying is accomplished by the contact between the hay and the hot metal of the perforated sheet. Intermittent action of the feed tends to back the hay against the angle bars. The rotating stirrers which clear the bars by one-half inch, level off the moving hay and keep the bottom covered. This tendency of the hay to lag almost disappears after a travel of about 8 ft as the hay slides more easily as soon as the layer next to the hot sheet is dried.

The stirrers serve the dual purpose of keeping the hay fluffed up and the layer even. At the upper end of travel the small revolving cylinder marked "knocker" forces the hay through the spaces between the bars to the return side of the conveyor underneath. On the return side the conveyor travels in a pan with a solid bottom. The hot air enters the pan through slots and nozzles on the sides. It was found that with a perforated bottom a certain amount of dust would sift through to the hot air space where it would char and catch fire.

The solid bottom cured the dust sifting, but it slowed up the drying. Next season the perforated bottom will be reinstalled with a supplementary dust catching pan underneath.

The hinged baffles have the purpose of deflecting the hot air to the top of the hay and also to form a space where the hot air intimately mixes with the hay tossed up by the rotating stirrers.

At the exit there is an airseal flap with canvas flaps on the lower edge which maintains contact with the angle bars as they pass underneath. As the hay passes from the drier proper, it is forced by a second knocker to the cross carrier fitted with an airseal which drops the dry material to the ground or to an elevator. The elevator was fitted to convey the dry hay into a truck. As the machine delivers about 800 lb of dry material per hour, it was often inconvenient to keep the truck out of other service while waiting for a load to accumulate. This year the elevator was discarded and the hay was hand loaded and handled by a man with a half-ton pickup truck.

The feeder is a discarded manure spreader with the front end raised high enough to permit the chopped green hay to drop on the drier. The hay is chopped by an ordinary ensilage cutter running at a slow speed with only two fan blades retained. It throws the hay directly into the feeder.

Hot air is blown into the drier at 340 F (degrees Fahrenheit), which has been found to be the upper limit if scorching is to be avoided. At that temperature the hay has to be kept moving or it will scorch in a very short space of time.

The efficiency of the drier, based on fuel supplied and water evaporated, is 44 per cent. The fuel for the engine driving the fan and the small engine driving the stirrers is charged against the drier and is included when calculating the efficiency.

The cost for fuel per ton of dry hay when working on hay with 58 per cent moisture and drying down to 15 per cent moisture is about $3.25 per ton of dry hay.

In practice it was found that the layer of hay entering the machine should not exceed a thickness of 3 in. A thin layer taking 8 min to pass the 37 ft through the machine produced more even and rapid drying than a heavier layer moving at a slower speed.

In the development of a portable drier contradictory conditions have to be met. The size and weight have to be

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 30, 1938. Mr. Aitkenhead (Fellow A.S.A.E.) is professor and head of the agricultural engineering department, Purdue University.

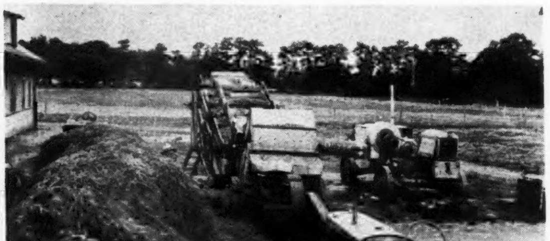

FIG. 1 PORTABLE DRIER SET UP FOR OPERATION AT PURDUE UNIVERSITY. THE DRIED HAY IS TRANSFERRED TO A BLOWER WHICH DELIVERS IT TO THE HAY MOW

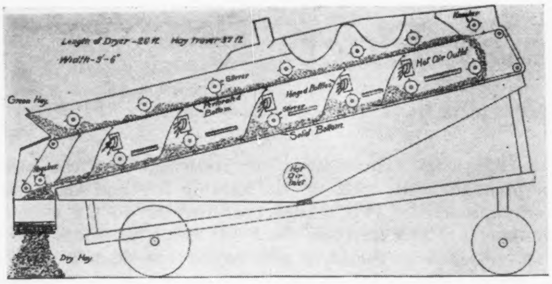

FIG. 2 THIS DIAGRAM SHOWS THE PASSAGE OF THE HAY AND AIR THROUGH THE PURDUE DRIER

kept low to obtain portability, and to be practical it must have capacity. Observation leads to the conclusion that the machine would be more efficient if the hay were given 20 ft additional travel. This would permit lowering the heat and air pressure.

In practice the hay is allowed to lie in the swath for about 3 hr, at which time the moisture is around 60 per cent.

The evaporation curve (Fig. 3) shows that at this moisture content approximately a ton of water has to be driven out to obtain a ton of dry hay. Above this moisture content the fuel consumption rises rapidly due to the amount of water to be evaporated.

The heating unit consists of an oil furnace and a 40-in multiblade fan mounted on wheels. The furnace has a circular bricklined fire box 30 in in diameter by 3 ft long. The burner capacity has an upper limit of 12 gal of fuel oil per hour. Surrounding the fire box is a sheet iron jacket, leaving a 3-in space. The fan draws the air between the jacket and the fire box. This air mixes with the products of combustion immediately back of the fire box and is delivered directly to the hay-drying unit by the fan.

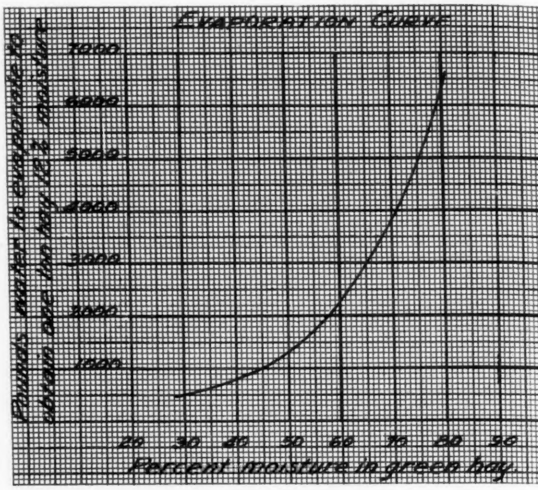

FIG. 3 EVAPORATION CURVE

Hydraulics of Open Ditches

(Continued from page 178)

The following steps in the hydraulic design of open ditches are desirable:

1 Make field investigation to determine character of soils which would be encountered in ditch construction, degree of stability of side slopes, proper depth of drain, elevation of fields, buildings, roads, etc., which are to be protected.

2 Obtain profiles and cross sections at 100-ft intervals of the existing channels. Obtain elevations of tile outlets which are often the controlling factors in the design of ditches.

3 Determine the degree of drainage required and select a runoff coefficient on basis of Fig. 5 or suitable data.

4 Determine probable degree of maintenance.

5 Select value of n to use and compute required size of ditch by use of Kutter's formula.

6 Make tentative design of ditch which will furnish adequate degree of drainage protection, selecting tentative depth, bottom width, and side slopes.

7 Make study on profile and determine the final design including size, cross sections, and elevations of channels.

The final selection of size, depth, and cross section of a ditch must be done very carefully in order to obtain the results desired and to avoid unnecessary excavation. This is ordinarily done by means of a profile study. On this profile should be plotted the elevations of fields, roads, buildings, and other structures to which it is desired to afford protection. All tile outlets should be plotted as they often control the depth of ditches. The hydraulic gradient should be drawn in so that the desired degree of drainage or overflow protection will be provided to protect the various lands and structures along the ditch. Considerable experience and judgment are required to place the hydraulic grade in proper relation to the elevation of the ground. Rule-of-thumb decisions such as making the depth of water nine-tenths the depth of the ditch are to be avoided, since the depth varies considerably along the profile, and the problem deserves a more careful study. Occasionally it is found that it is not economical to place the hydraulic gradient at low enough elevation in relation to low sloughs or potholes to render such areas the same degree of drainage protection as the larger fields. These problems must be worked out on the basis of the value of the lands protected as compared with cost of providing the additional protection. It is believed that often considerable expenditure can be saved by careful study of the hydraulic gradient in relation to the elevation and economic importance of the various lands and structures to be protected.

The problem of maintenance will only be mentioned in this paper, but its importance in relation to hydraulics must not be overlooked. It has been found that a ditch that has been poorly maintained may at times have only one-third or one-half of the capacity of the ditch which has been well maintained. The probable degree of maintenance that the ditch will receive must be given careful consideration in hydraulic design.

This paper has briefly discussed only the most important points in the hydraulic design of ditches. Space has not permitted discussion of other points such as the desirability of flattening out irregularities in grade to avoid excessive erosion.

Silo Problems Created by Grass Crops

By J. W. Bartlett

THE preserving of grass crops as silage has gained a greater momentum among the dairy farmers of this country than perhaps any other recent development in dairy farming. While the preservation of grass as silage has been practiced in the old country for a great many years and was studied at Kansas State Agricultural College some twenty-five years ago, it was not until recently that farmers, silo producers, engineers, and farm machinery manufacturers, have all become enthusiastic on the same subject. In fact, grass silage development has reached a development that is running ahead of the research. The problem in the dairy research field today is one of keeping ahead of farm practice.

The New Jersey Agricultural Experiment Station does not claim any priority rights in the promotion of the grassland farming program. Through necessity it did adopt a grass silage, better haylands, and improved pasture combination about seven years ago.

Five problems seem to stand out as one reviews the field. These are:

1 The relation of moisture in grass to its successful preservation as a silage

2 Economical methods of harvesting and silo filling

3 The correct preservative and its application

4 The roughages to put in the silo

5 How much grass in the form of silage or hay shall we preserve for our livestock?

Moisture creates an engineering problem for the agricultural engineer and the silo manufacturer. Experience at our station leads us to recommend that the farmer who puts up grass with a moisture content between 70 and 80 per cent will most generally be successful in securing a good product, providing he has applied enough preservative. It would take too much time here to discuss all of the details involved in this moisture question. However, we must learn more about pressures and temperatures within the silo and materials to be used in silo construction that will stand up over a period of years against the ravages of the silo juice. The question of seepage is one which has not been answered. We have to ask ourselves such questions as, Shall we build tight silos? Shall we allow the seepage to run away through drains? Need we worry at all about the juice which runs away from the silo that has been filled with grass of high moisture content? Moisture is directly related to the tonnage of dry matter that may be ensiled. We have a silo which will hold 60 tons of dehydrated hay, 250 tons of corn silage, or 185 tons of mature grass. This year the same silo filled with grass containing 80 per cent moisture finally held 330 tons. More dry matter went in that silo this year than any other time.

If this grass silage program is to be adopted generally, its preservation must be simple and practical. The method must be one that can be used by the average farmer with a minimum of farm machinery. We have, therefore, in our advice to the farmer tried to be safe in our suggestions and have advised him to get his grass from the fields just as soon as possible after cutting.

Proper equipment is one of the most pressing problems at present. The handling of green grass is, in any event, a hard job. To handle it quickly, easily, and economically requires simple equipment which is strong enough to stand up. It would appear that a 5-ft swath will serve best as it

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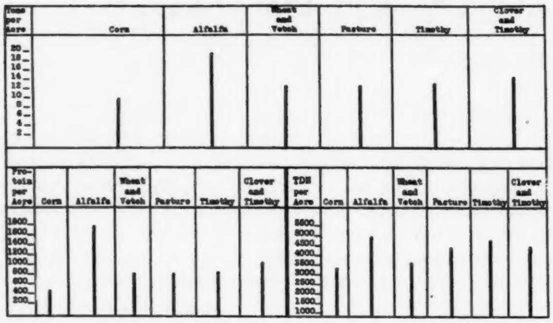
Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 30, 1938. Dr. Bartlett is professor of dairy husbandry at the New Jersey Agricultural Experiment Station.

(RIGHT) A BATTERY OF SILOS AT THE NEW JERSEY AGRICULTURAL EXPERIMENT STATION. (BELOW) GRASS FOR SILAGE IS HAULED IMMEDIATELY AFTER CUTTING

YIELDS OF GRASSES AND LEGUMES FOR SILAGE ON SOME FARMS UNDER GRASSLAND MANAGEMENT COMPARED TO AVERAGE CORN YIELDS (1937)



will allow the use of a hayloader to pick up the green material directly, without the use of a rake. On level to rolling country, a windrower attachment has proved quite satisfactory. On hillsides, however, the windrower will not do a good job, and grass will be left in bunches or will clog the mowing machine. Hauling small loads with few men seems to be better than trying to haul large loads of two or three tons of grass with a large crew.

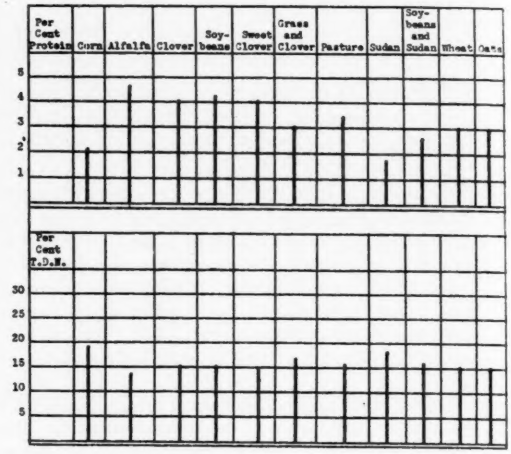
As to the preservative, considerable research is now being conducted with several materials. The New Jersey station has given more attention to the use of molasses than any other. At the present time both molasses and phosphoric acid are being used at our station for this purpose. Our hope in the use of molasses is that there may be considerable feeding value left for the nutrition of the dairy cow at the same time that the molasses has served as a preservative. We have this year used up to 300 lb of molasses per ton and will, during the winter feeding season, determine the value of such quantities in the dairy ration with milking animals and growing heifers.

Molasses has been introduced into the silage cutter both by gravity and by pump. We have also used a force pump to elevate the molasses to the top of the silo, where it has been released into the distributor pipe. Pumps are an additional cost, require more attention, and add to the bothers of the farmer. More research on preservatives and their method of application is seriously needed.

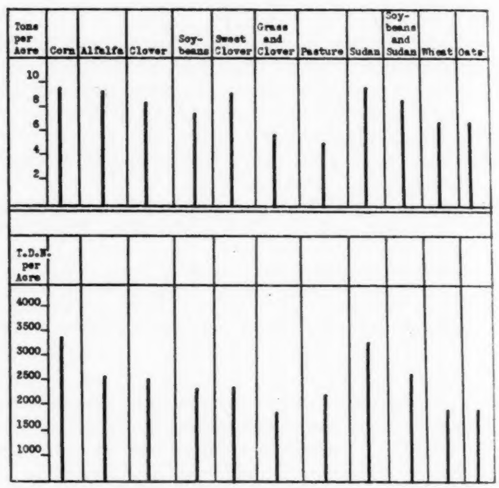
The question of green materials to put in the silo is one which need not concern us much. These crops which will grow best in a community will result in the most economical silage. A year or two ago we would not have believed that corn would be threatened in this program by grass, legume, or cereal crops. If we consider average yields of corn, statistics reveal that ten tons per acre is an average for our state, and yet many farmers boast that they grow 20 tons per acre. Comparing this yield in terms of protein and total digestible nutrient content with cereal grass and legume crops, our census reports would show that corn leads.

The accompanying charts show that, in tons per acre on a green weight basis, corn, alfalfa, sweet clover, sudan grass, and soybeans yield somewhere between 8 and 10 tons of green weight per acre. On the basis of the graphs which deal with the protein and total digestible nutrient content of 100 lb of the various crops that may be used for ensilage, we note that the protein content of alfalfa is approximately twice that of corn. We also note that clover, soybeans, and even pasture will exceed corn in protein yield. On the other hand, when we consider the total digestible nutrient content per acre of each of the crops, corn leads with quite a perceptible margin. The truth of

PROTEIN AND TOTAL DIGESTIBLE NUTRIENT CONTENT IN 100 POUNDS OF VARIOUS CROPS USED FOR ENSILAGE



AVERAGE YIELDS PER ACRE OF VARIOUS CROPS USED FOR ENSILAGE IN NEW JERSEY



this matter, however, is that the average farmer fertilizes his corn with stable manure and usually adds from $3 to $8 per acre in commercial fertilizers.

Another chart shows a graphic story of what happened on several New Jersey farms during the past year where the same amount of money was applied to the fertilization of alfalfa, pasture, and other crops as is usually applied to the corn crop. We have actual photographs of fields from which 25 tons of green alfalfa were removed during the past season in three cuttings, and other fields from which as high as 26 tons of Ladino clover were harvested per acre in three cuttings. At the Walker-Gordon Farms at Plainsboro, N. J., a crop of wheat and vetch yielded in green weight per acre during the month of May approximately 11 tons. Immediately following the harvesting of this crop, soybeans were drilled as a second crop for the season. The yield in September was approximately 10 tons of green weight per acre. Thus it offered the possibility of growing annual crops high in protein that will yield over 20 tons to the acre. In our program of grass farming, oats and peas or other cereal crops are being *(Continued on page 186)*

Labor Efficiency and Power Economy in Corn Production

By J. Brownlee Davidson

THIS PAPER is intended to be a review of the engineering aspects of the production of corn. The principal matters to be considered will therefore be labor efficiency, power economy, and expenditures for farm machinery, for these represent the particular interests of the engineer. In the scientific aspects of corn growing, soil management, seed selection and treatment, plant culture, and problems of marketing and feeding are the particular concern of the agronomist, the economist, and the animal husbandryman, but the execution of the program of corn growing, once formulated, is the specific interest of the engineer.

Labor efficiency and power economy in the growing of the corn crop varies greatly between different sections of the country. This variation, in the author's opinion, is much greater than is generally understood.

A recent study of the labor required to grow an acre of corn during the 1932-36 period reported 17 man-hours for the "corn area" and 23 for the United States[1]. Since this study was general in scope the labor expenditure reported may be accepted as normal practice. Since the average yield was a little over 40 bu, the average time required to produce a bushel would be 25.4 min. Power requirements were not reported.

Individual records of the members of the Iowa Farm Business Association furnish data concerning the labor and power used in growing corn during the years 1936 and 1937. Members of these associations are recognized as the most progressive class of farmers and are much more efficient than the average. A study of these records produced the data shown in Table 1.

TABLE 1. POWER AND LABOR USED IN GROWING AND HARVESTING CORN AS INFLUENCED BY KIND OF POWER USED

Kind of power	Horses	2-plow tractor; horses	3-plow tractor; horses	2-plow gen-purp. tractor; horses
No. of farms	53	59	9	54
Acres per farm	187.5	215.6	295.8	340.1
Acres in corn	61.7	68.7	91.4	128
Yield, bu	44.3	53.6	53.6	57.8
Man-hours per acre	14.84	12.80	11.58	10.41
Drawbar horsepower-hours per acre	30.88	28.56	27.25	27.46

Labor required per bushel on two-plow general-purpose tractor farms is 10.8 min.

Unpublished thesis, by Wylie D. Goodsell.

Cost and Utilization of Power and Labor on Iowa Farms (Bulletin in Press), Iowa Agricultural Experiment Station.

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Ill., November 29, 1938. Dr. Davidson (Charter and Fellow A.S.A.E.) is professor and head of the agricultural engineering department at Iowa State College, and his paper was prepared in collaboration with C. K. Shedd (Fellow A.S.A.E.), agricultural engineer, U. S. Bureau of Agricultural Engineering and E. V. Collins (Mem. A.S.A.E.), research professor of agricultural engineering, Iowa Agricultural Experiment Station.

[1]Iowa Farm Economist, Oct. 38, p. 15.

These expenditures for labor and power should be compared with the data now to be reported from actual tests. In 1933 careful observations were made by the U. S. Bureau of Agricultural Engineering and the agricultural engineering section of the Iowa Agricultural Experiment Station, of the labor and power requirements of growing corn in Story County, Iowa, using various techniques.

These observations were made with such care that the data obtained can be accepted as representing a high degree of accuracy. Although listing, drilling, and several short-cut methods of preparing the seedbed and cultivating the crop reduced the labor requirements, these methods tended to reduce the yield under that obtained with the conventional method of surface planting in checks. In 1933 when the detailed observations of labor and power requirements for growing were made, 2.5 man-hours were used in harvesting the crop. In 1938, owing to the use of pneumatic tires on all equipment, permitting higher field speeds, the use of extensible, quickly manipulated hitches, and more rapid means of unloading, the labor was greatly reduced. Table 2 therefore reports the labor, power, and machinery used in growing an acre of corn in 1933, and its harvesting by methods observed in 1937.

Data in Table 2 should not be looked upon as a record obtained by special effort, but rather the result of good practice and management, which could be duplicated with ordinary effort under the same conditions.

TABLE 2. LABOR, POWER, AND MACHINERY EXPENDITURES IN GROWING SURFACE CHECKED CORN

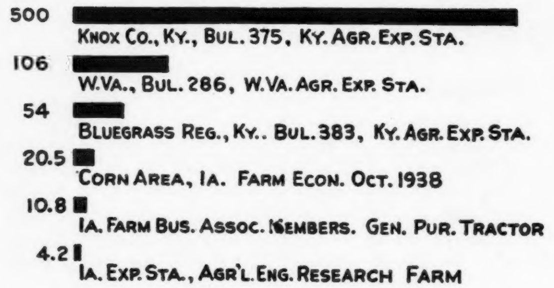
Operation	Machine used	Labor man-hours per acre	Power, horse-power-hours per acre
Plowing	three 14-in moldboard	1.28	13.1
Harrowing			
Smoothing (2)	six-section	0.30	
Disk (1+)	21-ft single + work on dead furrows	0.32	4.8
Planting and cultivating	Combination four-row cult. & planter	0.77	2.3
Weeding	21-ft weeder	0.15	
Cultivating, 3 times	four-row	1.40	5.6
Total for growing		4.22	25.8
Harvesting	Cornpicker two-row mounted	0.55	
	Hauling 3 wagons	0.08	4.9
	Unloading	0.20	1.0
	Servicing picking equipment	0.08	
Total of harvesting		0.91	5.9
Total of growing and harvesting		5.13	31.7

NOTE: With a total of 5.13 man-hours per acre for growing and harvesting and a yield of 74.3 bu, the labor per bushel is 4.2 min.

These data are for the conventional method of planting corn in the central part of the corn belt, that is, surface planting in checked rows for cross cultivation. Drill planting requires somewhat less labor and listing was carried out in 1933 with 1.14 hr less labor and 9 hp-hr less power per

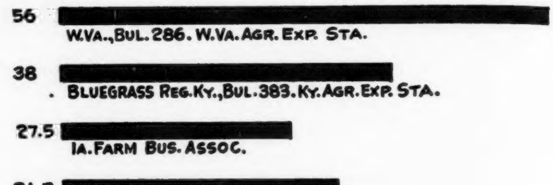
LABOR REQUIRED TO PRODUCE CORN

MINUTES PER BUSHEL



POWER REQUIRED TO PRODUCE CORN

HORSEPOWER HOURS PER ACRE



acre. But drilling and listing have resulted in less yield in the experiments conducted at the Iowa station. Listing appears to be better adapted to the sections of the corn belt with less rainfall.

In Table 2 we have a picture of modern practice in growing corn in terms of the basic units of man-hours of labor and drawbar horsepower-hours of power.

It should be recognized that farm operations are interferred with by the weather and cannot be so well controlled as factory operations. The usual farm method of meeting the problem of weather interference is to do more than one day's work within the twenty-four hour period when conditions are favorable. The tractor lends itself well to this method.

If normal unit costs for labor and power are applied to the data of Table 2 and the other items of cost are added, a general economic picture of the corn growing enterprise is obtained. These other items can be roughly grouped into three groups for the purpose in hand, namely, cost of the use of machines, a miscellaneous item including cost of seed storage, etc., and use of land.

For the sake of comparison let us proceed with the assignment of dollar and cents values. Assume labor at 30 cents and power at 5 cents per drawbar horsepower-hour. The latter is arrived at by assuming the cost of operating a tractor delivering 10 drawbar horsepower at 50 cents per hour.

Annual machine costs are rather difficult to arrive at. In the reports of the members of the farm business association in Iowa the annual cost of machinery per acre varied from \$2.51 to \$3.08, but these figures included some machinery hire with labor and the cost of processing machinery including feed grinders. This subject might be entered into to considerable length, but for our purpose it might be assumed that an investment in machinery (not including power equipment) of \$6.67 per acre is required when a corn picker is not used and \$10.00 per acre when a picker is used. If the annual cost is assumed to be 15 per cent of the investment, the annual cost per acre would be \$1.00 per acre for hand picking and \$1.50 for machine picking. It is recognized that new equipment would cost more, but on every going farm the equipment should reach the state when it approaches a value of one-half first cost or a state where the equipment on the average is half worn out.

Miscellaneous items will vary, particularly as to whether hybrid seed is used. Eight pounds of seed at 10 cents costs 80 cents, to which an additional 70 cents might be added for incidentals. Good corn land in the central corn belt now rents for about \$8.50 per acre. No expense is charged to fertilizer.

With these assumptions, Table 3, of the cost of growing corn is evolved.

TABLE 3. COST OF GROWING CORN

	Good practice		Advance practice	
Labor, man-hours	17 at 30 cents	\$5.10	5.12 at 30 cents	\$1.50
Power, hp-hr	30 at 8 cents	2.40	30 at 5 cents	1.50
Use of machinery		1.00		1.00
Miscellaneous		1.50		1.50
Use of land		8.50		8.50
		\$18.50		\$14.50

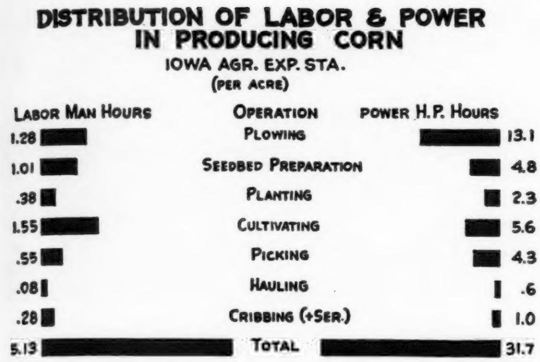
With this picture before us, let us speculate in regard to the possible economies and efficiencies for the future. Can labor be still further reduced, the cost of power lessened, or the cost of the use of machinery lowered?

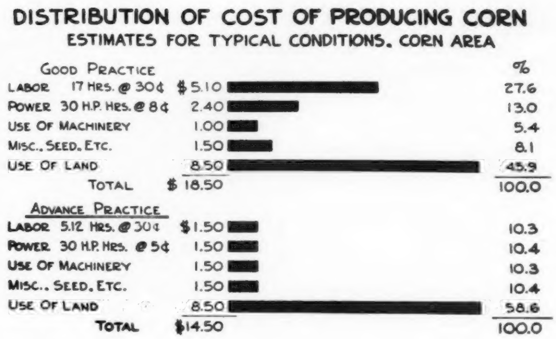
Let us consider first where labor is used. The labor of plowing is given as 1.28 hr per acre. The labor and power required for disposing of the residues of the previous crop are not listed because the land was stubble and no expenditures of power and labor were required. To plow 0.8 acre in one hour (1 acre in 1.28 hr) with a two-bottom, 14-in plow with the usual 82½ per cent efficiency requires a field speed of about 3.4 mph. This is practicable under favorable conditions with any of the better two-plow tractors. To reduce the time of plowing more power will be required. A speed of 4.3 mph would require about one-half more power, and reduce the labor of plowing 22 per cent to one hour per acre. Such a tractor would, under usual conditions, have more power than could be used economically. Perhaps the disadvantage of this larger power unit could be taken care of by a reduced rotative speed, as will be discussed later.

Power required for plowing is 41 per cent of the total and raises a question as to whether plowing is really necessary. Listing, in the experiments at the Iowa station, was performed with an expenditure of 0.87 man-hours of labor and 6 hp-hr per acre, for single listing. Listing, however, resulted in reduced yield of corn. Just why the yield is less was not determined. It was noticed that the corn plants were slower in getting started, indicating that perhaps the shading of the ground, colder soil, and less available fertility in the deeper soil were causes.

For the secondary seedbed preparation 1.01 man-hours and 6 hp-hr were observed for twice over with disk harrow and smoothing harrow and once over with a cultivator at the time of planting. It might appear that it would be easy, with a somewhat better arrangement, to reduce the labor of this operation materially. A double-disk and smoothing harrow combination, when adequate, should reduce the time with a two-plow tractor to 0.5 hr.

Planting requires little power but much skill. It can be combined with other operations. A four-row planter and cultivator combination used in the tests reported required 0.77 man-hours and 2.3 hp-hr per acre.





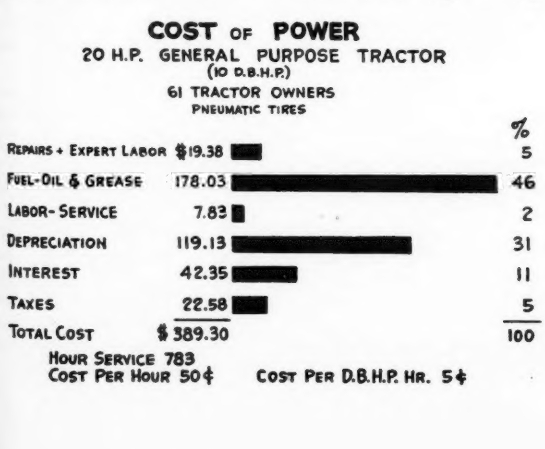
The requirements of the best seedbed for corn have not been fully established. It might be possible to combine into one operation all seedbed preparation and planting. In some trials where the seedbed was prepared with the pulverator, the corn was planted without further preparation. It would be comparatively easy to make the planter a part of the combination, if it were not for the problem of multiple-row cultivation which calls for planting the same number of rows as are to be cultivated.

Cultivating the corn crop with weeder and four-row cultivator required 1.94 man-hours and 5.6 hp-hr. Cross cultivation was most tedious. Experiments during recent years have indicated that, if sufficiently thorough, the number of cultivations may be reduced.

The tractor offers so much in the way of an opportunity to use mechanical power more effectively in the destroying of weeds that it will surely not be long until more adequate machines are developed. The drawn shovel or sweep mechanism is easily recognized as a holdover from animal power.

If power-driven cultivating mechanism can be made to register on the corn hill and cultivate between the hills, check-rowing equipment will be unnecessary. Such a planting system would be well adapted to strip farming.

In five years of experimentation at the Iowa station through the use of pneumatic tires on tractors and wagons, permitting larger loads to be hauled at a higher speed, the use of extensible tongues for quick hitching, larger wagons up to 100-bu capacity, and the use of a pit elevator which does not require the operator to wait for the ear corn to be slowly fed to the elevator, the labor for harvesting has been reduced from 2.5 to 0.91 hr per acre. There is little prospect of any great reduction of labor with present equipment in the harvesting of corn. The modern corn picker, mechanically and economically, leaves much to be desired. The conditions for its use must be favorable and a larger acreage than average is necessary to make its use economically inviting.



The selection of hybrid varieties with stalks that stand well and hold the ears tenaciously help to make the machine practicable. Field shelling might not save so much up to the time of cribbing, but the economy and conveniences of conditioning and handling shelled corn make experiments with field shelling inviting.

Experiments for five years at the Iowa station indicate that the single-plant hill consistently gives a higher yield. In the experiments the increase varied from a negligible amount for the dry years of 1934 and 1936 to as much as 26 per cent in 1935. Perhaps the average increase could be expected to be from 5 to 10 per cent. The explanation for the increased yield is credited to the ability of a single plant, not crowded by competing plants, to use the moisture and fertility of the soil and the sunlight to better advantage. Drilled corn did not give the same results in the experiment. Whether the gain in yield will justify a change from the conventional method of planting corn remains to be seen.

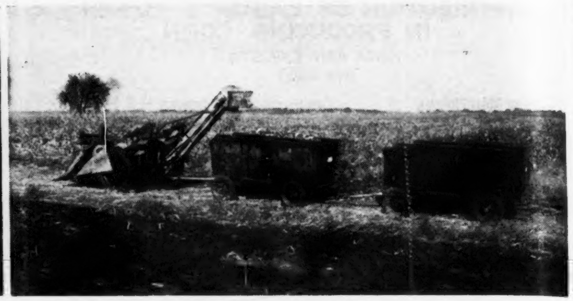
It will perhaps be recognized that advances in the use of power in corn production will come about more through the reduction in the cost of energy than from efficiency in its use. Table 4 has been prepared from data obtained from the records of members of some of the Iowa Farm Business Association. The most economical power, according to the records of the farmers, was obtained by those having two-plow, general-purpose tractors mounted on rubber. The fact that the owners of these tractors made extensive use of their tractors insured low unit cost of energy.

TABLE 4. COST OF POWER

20-hp general-purpose tractors (10 drawbar-horsepower assumed)
(Records of Iowa Farm Business Association,
61 tractors on pneumatic tires, 1937)

Repairs and expert labor	$ 19.38
Fuel, oil, and grease	178.03
Labor (service)	7.83
Depreciation	119.13
Interest	42.35
Taxes	22.58
Total annual cost	$389.30
Hours of service	783
Cost per hour of tractor use	$0.50
Cost per drawbar horsepower-hour	$0 05

Most of these items are the average of those recorded by the farmers. Some items, however, called for estimates by the economist making the compilation. The items of depreciation, interest, and taxes seem high, but most of the tractors were new and the magnitude of these items reflect this situation. The largest item, making up 46 per cent of the total, is that of fuel, oil, and grease. This would



(LEFT) COMBINATION OF CULTIVATOR AND PLANTER PERFORMING FINAL SEEDBED PREPARATION AND PLANTING AT ONE OPERTION. (RIGHT) LARGE CAPACITY WAGONS WITH EXTENSIBLE TONGUES REDUCE LABOR REQUIREMENT AND PERMIT ONE-MAN OPERATION

appear to be the most vulnerable point of attack in reducing cost. Low unit cost of fuel and efficiency are the means to the end. Higher efficiency will be equally effective if applied in fuel consumption or in power application.

In the growing of corn a rather large power unit is needed for economy of labor in plowing. In other operations much less power is generally needed. A motor with high speed for plows and a wide range of governed speeds for light loads would seem to be in order. If the engine is allowed to rotate at a high speed for a light load, the result is high fuel consumption per horsepower-hour. The energy consumed in overcoming friction and in driving the fan at high speed is great. The saving of fuel to be secured by operating the motor at lower speeds for light loads is well worth considering.

When plowing, the tractor needs weight to increase adhesion, so that its full power can be delivered to the drawbar. With mounted planter, cultivators, and pickers weight becomes a burden. This would seem to indicate that tractors should be made with a large unit of easily detachable weights.

What will these savings amount to if assembled into a management program? On the basis of present available information it would appear easy, under favorable topographical conditions, to reduce the 5.13 man-hours for producing corn observed for advanced conditions to less than 4 man-hours. The amount of power cannot be greatly reduced without a change of cultural methods but the cost could easily, with changes in design well within our reach, be reduced as much as one-fourth.

Many persons familiar with corn production will be inclined to call attention to the great advances now possible if the advanced practices of the present were more generally followed and such persons will ask, why introduce additional economies and efficiencies? Is this not a problem in itself? It might be suggested that more rapid advance may be expected when salesmanship for corn-growing equipment is more closely related to the economics of corn growing.

The relative large charge for the use of corn land is worth consideration. May it be suggested that this is due to competition between corn growers. The same land would grow as much corn if the charge was less. There is no assurance that, with free competition, an increase in the price of corn will not, in the end, be reflected in an increase in the cost for use of land.

Silo Problems Created by Grass Crops

(Continued from page 182)

used as a nurse crop in order to get our grassland from sod back into sod in one year without cropping it with corn.

This past year we have made grass silage from mixed grass pasture which yielded 9 tons of green weight per acre on the first cutting. This pasture was then used for grazing during the remainder of the season. When alfalfa or other legume crops and even grasses will yield a total of 1,800 lb of crude protein per acre and 5,000 lb of total digestible nutrients per acre, it does not seem that we shall be able to prevent a revolution in our roughage program.

Research work at the New Jersey station during the past two years has shown that growing heifers may be developed to normal size on a pasture, hay, and grass silage diet from the time they are 12 to 15 months of age. Our records show, however, that we get from 10 to 15 per cent better growth where from 4 to 6 lb of hay is used daily in addition to about 36 lb of grass silage during the winter months. In comparing grass silage and hay with corn silage and hay, corn silage and grass silage, and grass silage alone, grass silage and some dry hay produced slightly more milk during a three months' reversal feeding trial, than did any of the other combinations of roughages. The condition of the milking herd was also noted during the various feeding trials. With grass silage and approximately 6 lb of hay per day, cows gained in weight, while in all other feeding trials there was a slight loss in weight. Grass silage and hay maintained high color and a fine flavor in the milk.

We have received a great many inquiries as to the possibility of barn construction using the one-story barn with silos for storage of roughage. It would appear to date, however, that we cannot safely recommend the use of grass silage as the entire roughage diet for the milking cow or the growing heifer if we are to get maximum results. There is still the problem of constructing some sort of storage for dry hay.

The problems which have been presented definitely show that there is still need for a great amount of research before we shall know the full answer to the question of preserving green crops in the silo. It will be several years before many of the questions may be answered. Grass programs are here to stay and there are a great many problems for the engineer and for the silo manufacturer. I would, however, again repeat that we must think of the preservation of green crops in terms of the average dairy farmer. Costs must be kept low. Simple equipment must be adopted in order that the average dairy farmer can harvest his crops without fuss or furore and can be sure that he is going to have a good feed for his dairy herd.

Stressed Plywood Coverings for Poultry Brooder Houses

By Henry Giese and George H. Dunkelberg

WOOD HAS been a popular material for farm building construction because of its availability, appearance, low cost, and the comparative ease with which it can be fabricated. In many cases, however, these properties have worked against the best interests of good construction, since fabrication by the careless or unskilled has resulted in buildings not suited for their intended use and short lived because of poor construction methods.

Few industries are more dependent upon the consumer than is the lumber industry, yet few consumers are less able to carry the responsibility of adequate construction than is the farmer. Without architect, skilled contractor, building code, or building inspector, and with few advisers, it is not surprising that the farmer hesitates to build and makes mistakes when he does.

Within recent years there has been a definite trend toward a greater degree of mill fabrication and a more skillful use of the material. One of the most significant of these developments is plywood.

The merit of plywood as a structural material is almost self-evident. The U. S. Forest Products Laboratory (5)[1] makes the following statement:

"Wood, as is well known, is a nonhomogeneous material with widely different properties in the various directions relative to the grain. . . . Were wood a homogeneous material such as cast iron, having the same strength properties in all directions that it has parallel to the grain, it would be unexcelled for all structural parts where strength with small weight is desired.

"It is not always possible to proportion a solid plank so as to develop the necessary strength in every direction of the grain. In such cases it is the purpose of plywood to meet this deficiency by crossbanding, which results in a redistribution of the material.

"In building up plywood a step is made in obtaining equality of properties in two directions, parallel and perpendicular to the edge of a board."

Because of its equalized strength properties, its availability in large sheets, and its relative freedom from checking and splitting, plywood may find successful application in all of the buildings commonly found on the farm.

Believing that the properties of plywood make it eminently suitable for the construction of light-weight movable buildings, the first project in this study, sponsored by the Douglas Fir Plywood Association, related to the design and construction of a poultry brooder house.

The effectiveness of a poultry brooder house depends largely upon the ease with which it can be moved from place to place in an effort to keep the chicks on ground free from contamination by disease germs. Most brooder houses are too heavy for easy moving and soon rack to pieces if so moved.

A study of current practice showed that a 10x12-ft house which will shelter from 250 to 300 chicks, appeared to be the most satisfactory size.

An arched roof was selected for this study because it made possible a minimum of exposed area with a maximum of clearance and work space for the operator. It also appeared to offer some advantages in rigidness of construction, since glued bent rafters change the direction of the grain of the wood to meet applied stresses, and side walls become structural members. Plywood panels were also glued to the rafters to increase the strength of the joints and to seal them against the infiltration of air.

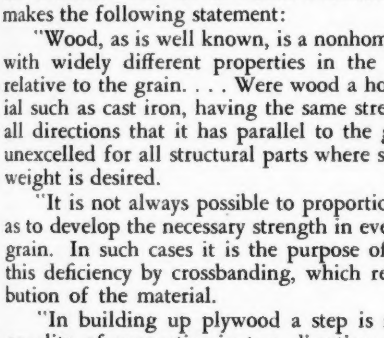
Three brooder houses were designed and constructed, each subsequent design modified according to experiences gained in the earlier ones.

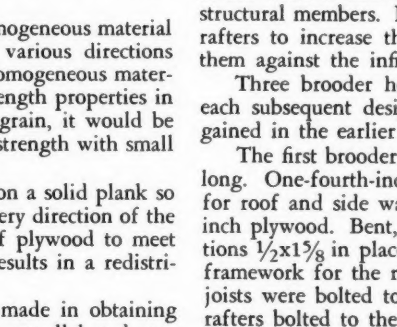
The first brooder house was made 12 ft wide and 10 ft long. One-fourth-inch wallboard-grade plywood was used for roof and side walls. The floor was made of one-half-inch plywood. Bent, glued rafters formed of four laminations $\frac{1}{2}$x$1\frac{5}{8}$ in placed 2 ft 0 in on centers were used as a framework for the roof panels as shown in Fig. 1. Floor joists were bolted to the skids and the lower ends of the rafters bolted to the joists. Framing members were glued together. Both exterior and interior of the house were painted with aluminum paint.

The second brooder house was 10 ft wide and 12 ft long. Sheathing grade of plywood was used for coverings, 5/16-in for the roof and sidewalls and $\frac{5}{8}$-in for the floor. Considerable simplification was accomplished in construction details, although dimensions of framework materials and windows were unchanged. Greater protection was afforded the plywood at the base of the roof by an edging of shiplap. Asphalt roll roofing was cut into suitable lengths and cemented in place with hot asphalt and roofing nails.

Journal paper No. J-617 of the Iowa Agricultural Experiment Station (Project No. 555). Released for first publication in AGRICULTURAL ENGINEERING. Mr. Giese (Fellow A.S.A.E.) is professor of agricultural engineering, and Mr. Dunkelberg (Jun. Mem. A.S.A.E.) was research fellow in agricultural engineering, Iowa State College, (now assistant agricultural engineer, South Carolina Agricultural Experiment Station.)

[1]Numerals in parentheses indicate references cited at the end of this article.





(LEFT) FORM USED FOR MAKING LAMINATED BENT GLUED RAFTERS. (RIGHT) FRAMEWORK OF FIRST PLYWOOD BROODER HOUSE

The third plywood brooder house differs from the previous ones in both design and fabrication. It has rafters placed 4 ft on centers rather than 2 ft. The rafters extend only to the floor line, ends of the house are of resin-bonded plywood, the chick and ventilator doors are of metal, the roof is painted on the outside with aluminum paint, and the house is fabricated in sections.

Sheathing-grade plywood was used on the roof and edged with 2-in strips of 25-gage galvanized sheet steel bent to shape.

As trouble in the fabrication of the first two plywood brooder houses resulted from nonuniformity of the curved rafters, considerable time was spent in an endeavor to overcome this trouble. Several variations in numbers of plies and thicknesses of laminations were tried to see the difference in spring back when removed from the form. The spring back ranged from 4 in with three ½-in laminations to less than an inch with five 5/16-in laminations. The spring back increases (1) with a reduction in numbers of laminations, and (2) with an increase in thickness of laminations.

The rafters, as built for the new brooder house, were made of five 5/16-in laminations. About one inch of spring back was noted in these rafters and even this small amount increased both the time and difficulty of fabrication. The form should be so shaped as to compensate for this spring back.

In the new construction with the rafters coming only to the floor line, rafters 1½ in wide were adequate for easy fabrication. The bottoms of the rafters were held in place by means of small angle braces while the roof panels were being fastened. Construction was made easier by the use of prefabricated sections.

The floor was assembled as a unit and much work eliminated by replacing the former headers in plywood saddles by headers resting directly on the skids. As the rafters were designed to rest on the floor, no notches were cut in the plywood flooring. Both the front and rear ends were assembled as units, the plywood covering extended below the framing so the units could later be fastened to the floor. It appears that these units could be fabricated on a production basis very rapidly by using a jig to hold the framing members while the plywood covering was being applied. Such a jig would eliminate trouble with warped or crooked framing pieces.

Although 80 man-hours of time were required to construct this house, this time could be greatly reduced if the house were built on a production basis.

Test Data. Because the first house was constructed during the early winter, it was not possible to use it under actual operating conditions. It was used during the winter to house full-grown White Leghorns. Temperature readings were taken from a thermometer placed along the east wall 2 ft above the floor.

Records for sixteen days during January and February 1938 show inside temperatures well above those outside. The records were started during a comparatively warm period, progressed through a cold period and back to a warmer one. The temperature inside the shelter rose rapidly when the sun shone on the roof. The wind, however, seemed to have little effect on the inside temperature.

As movable poultry houses are subjected to severe racking when pulled around, it seemed desirable to provide a test that closely approximated use conditions.

A static test was made with the house supported rigidly at three corners and weights applied on the free corner to approximate the loads experienced while moving over rough ground. The deflection at the free corner was recorded with a dial gage in thousandths of an inch.

The load-deflection curve of the first static test was nearly a straight line, and a load of 759 lb, or three-quarters of the weight of the building, deflected the free corner only 0.227 in.

Similar tests were conducted on a gambrel and a shed-roof house, both 10x12 ft, so a comparison might be made with the plywood house as to strength and rigidity.

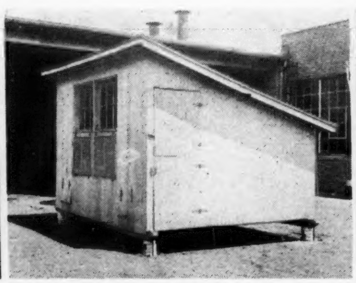
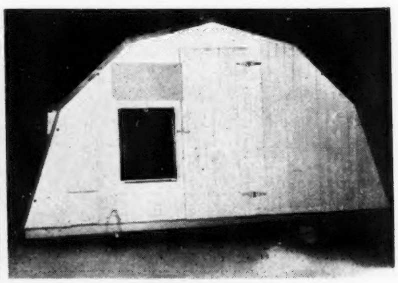
The gambrel-roofed house was apparently prefabricated in sections, later joined together on the job by means of bolts and nails. The skids were not fastened to the house in the original design, but it was necessary to fasten the skids to the floor joists with lag screws in order to conduct the test. This, of course, added rigidity that would not be evident in the house as generally set up.

The house was placed on 4-in blocks and fastened to the floor in the same manner as the plywood house. However, the deflection was so great that it was necessary to remount it on 8-in blocks in order to take deflection readings. Lead weights weighing approximately 60 lb each were used in the static loading, but the deflection for only one weight was so great that the dial gage with ¼-in capacity could not be used. Measurements of the deflection were taken with a steel rule. The results of the test are plotted in the curves accompanying this paper.

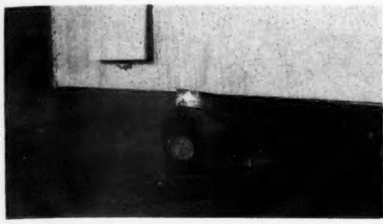
The lower frame of the side pieces was of 2x3-in material and nails through these into the floor were all that held the sides and floor together. The static load pulled the nails out, leaving an opening as shown. The roof section racked at a load of 530 lb so that the roofing cracked in several places. For this reason, no more load was applied.

The house weighed 1500 lb, which is one and one-half times as much as the plywood house. The skids were placed the short way of the house, so as to require a 12-ft gateway.

The shed-roofed house tested was constructed similarly to that shown in the Midwest Plan Service. This house has a double floor and is covered with vertical car siding. The skids are of 4x6-in material placed under the extreme sides of the house. As the test was conducted by fastening the skids down, the greater distance between them resulted

(LEFT) COMPLETED PLYWOOD HOUSE. (CENTER) SHED-ROOF HOUSE USED IN TEST. (RIGHT) GAMBREL-ROOF HOUSE USED IN TEST



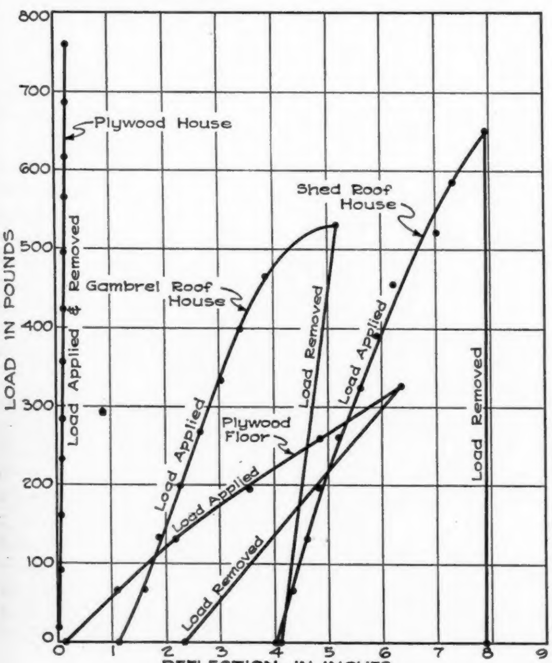
(LEFT) DIAL GAGE SET FOR READING DEFLECTIONS. (RIGHT) DEVICE USED FOR VIBRATING THE PLYWOOD HOUSE

in somewhat greater deflections than would have been evident otherwise.

The house was blocked 8 in off the floor and a steel rule used to measure the deflection. Considerable deflection occurred without applied load and some failure was visible when the house was under load as shown in the curves. The siding was spread noticeably and the roof was badly out of shape. The house had a permanent deflection of nearly 8 in when the 650-lb load was removed from the free corner. It appeared that the nailed construction slipped as the load was applied.

Vibratory Test. A small bench grinder with unbalanced weights on the shaft in place of grinding wheels was fastened securely to the floor of the shelter at the free corner. By varying oscillations with a variable-speed motor to synchronize with the natural period of vibration of the structure and using different sizes of weights, a vibration was secured with sufficient deflection to reproduce loads of approximately half the weight of the building. This was attained at a rate of about 500 vibrations per minute.

The first static test was plotted on a graph to show the relation between the applied loads and the deflection. The house was then vibrated for four hours, readings of the deflection, and the number of vibrations per minute being taken every fifteen minutes. A static test was run again to see if any change had been made in the rigidity of the structure. By comparing the average deflection of the vibration test with the two curves of the static tests, the average load imposed by the vibration test was secured.



LOAD-DEFLECTION CURVES FOR STATIC LOADINGS

In the vibration test more than 130,000 loads of 468 lb were applied. The only evidence of failure in the entire structure was the loosening of two bolts which fastened the joists to the skids at the corner opposite the applied load.

The static test following the vibration period showed a load-deflection curve from 0.008 to 0.040 in greater than the original static test. However, when the loosened bolts were furnished with larger washers and replaced, a static test showed a load-deflection curve which varied but little from the first. No damage to the plywood structure itself was evident.

The test results indicate that the shelter was extremely rigid even after the application of many loads. Apparently all loads applied were well inside the elastic limit of the structure. As the application of a static load resulted in structural failure of both the conventional and commercial houses, no vibration tests were made with them.

Comparison with Conventional Type. Comparison with the conventional type movable poultry shelter was made with plan No. 72701 from the Midwest Plan Service.

A study of Table 1 shows that the plywood shelters had less exposed area, smaller cubic content, and considerably less weight than the conventional type of movable shelter, although the floor space in all four was the same. The reduction of exposed area and cubic content should make the house easy to heat, especially when the decrease in air infiltration is considered. A shelter that weighs 1000 lb or less will be easily movable.

In order to compare the costs of the different shelters, prices were obtained from local retail yards. The number of hours of labor on each shelter was estimated and charged for at the rate of 60 cents per hour, and added to the cost of materials. Simplifications in construction resulted in lower labor costs in brooders Nos. 2 and 3.

At this time it looks as if the annual cost of a movable poultry shelter can be reduced nearly 40 per cent by using plywood. This estimate can be verified only by further tests and exposures under actual conditions. The comparisons made appear to justify the following observations and conclusions:

1 A curved or "gothic roof" with 6 ft clearance at the center makes a desirable shape for a brooder house with a satisfactory work space for the attendant.

2 A house 10 ft wide by 12 ft long proved more desirable than one 12 ft wide and 10 ft long.

3 A plywood roof covered with dark colored roll roofing absorbs heat from the (*Continued on page 194*)

TABLE 1. COMPARISON OF EXPOSED AREA, CUBIC CONTENT, AND WEIGHT

Shelter	Exposed area, sq ft	Cubage, cu ft	Weight, lb
Midwest 72701	507	720	2700
Plywood No. 1	433	600	950
Plywood No. 2	428	600	1000
Plywood No. 3	428	600	900

The Relation of Water Facilities to Agricultural Relief and Adjustment

By H. H. Gordon

THE Farm Security Administration, in carrying out its rural rehabilitation program, has frequently found itself seriously handicapped in the 17 western states because of lack of adequate small water facilities. This is particularly true with respect to domestic and livestock water supplies, and irrigation sufficient for home gardens and forage crops for livestock. Inability to produce subsistence has made rehabilitation more difficult—in fact, all too frequently prevented it—and, of course, inadequate domestic and livestock water has added greatly to the expense of operation and frequently contributed to misuse, or certainly uneconomic use, of land. The Administration was therefore very glad to contribute of its funds to the first year's operations under the Water Facilities Act, and to cooperate with other designated agencies of the U. S. Department of Agriculture in developing a water facilities program.

Interest of the FSA in water facilities is the rehabilitation of low-income farm families, and under special circumstances the reduction of direct relief costs through the use of water facilities designed to make possible maximum production of subsistence by families otherwise dependent upon emergency grants. From the FSA standpoint, however, the major justification for a water facilities program is the contribution it can make to the rehabilitation of low-income farmers through increased income, and improved living standards, rather than reductions in relief costs.

The rehabilitation of low-income farmers, therefore, resolves itself into a program of loans based on carefully prepared farm plans coupled with constructive guidance in improved farm management and conservation practices. A careful study of the low-income farmer will convince the thoughtful student that his condition is a result of maladjustments occurring over a long period of years, and that the correction must be brought about over a similar long period of years. We have abundant evidence that the solution of the problem does not lie in credit alone, but in the wise use of credit, brought about through a practical and constructive program of education, designed to teach the fundamentals of good planning and management.

In the water facilities program, adverse conditions of long standing have been recognized and an attempt made to offset these unfavorable conditions through long-term loans, a low rate of interest, and repayments based on ability to repay as indicated by the farm plan. Other FSA rehabilitation services entering into the solution of the problem are debt adjustment, greater security of tenure through long-term leases, and provision for group facilities where these are more practical and economical than individual facilities.

Where, as frequently happens, excessive debts are making rehabilitation impossible, debt adjustment through voluntary county farm debt adjustment committees, assisted by our trained debt adjustment specialists, undertake to adjust debts to ability to repay, keeping in mind the interests of both creditor and debtor. Debt adjustment may be through reduction in principal or interest, or both, or through more favorable terms in keeping with anticipated income.

The problem of tenure has a direct bearing on the water facilities program because frequently absentee landowners are unwilling or financially unable to finance the necessary facilities. Tenants are, therefore, deprived of the advantages of such facilities, unless some method can be devised whereby they can assume responsibility for the cost of the facility.

Under the water facilities program facilities may be constructed through the Soil Conservation Service, and made available to individuals or groups, or direct loans may be made through FSA to individuals or groups, the proceeds of the loans to be used for financing the cost of the desired facility. The loan method may be used only where full repayment of the loan is anticipated. In either case a farm plan must be developed jointly by the FSA and the SCS, to determine ability to repay, and prescribe the farm management and conservation practices to be followed by the applicant. Notes and security will be taken on the basis of ability to repay and the loan will be serviced by FSA, including guidance in carrying out recommended practices.

Realizing that many of the present sources of credit have a tendency to encourage overproduction of the principal cash crops, and that the average low-income farmer overlooks many opportunities to produce a very substantial part of his own living, FSA in its planning and supervision has stressed a live-at-home program. The first emphasis is on food for the family and feed for livestock, including the maximum use of subsistence livestock, and secondly, on sufficient cash crops to round out the farm enterprise, take care of operating expense, and repay obligations. This results in greater self-sufficiency on the part of rehabilitation families; a higher standard of living through their own efforts, and avoids conflict with crop adjustment programs.

Because the production of food for the family and feed for the livestock has such an important place in the rehabilitation of FSA families, and because lack of water makes such production impossible under arid conditions, a water-facilities program emphasizing small facilities, including irrigation for subsistence food and feed crops, is very important from the standpoint of both the administration and the families involved. Without such crops, living and operating expenses are frequently so high as to prevent rehabilitation and self-sufficiency for the families.

We are finding that much of our rehabilitation problem is caused by small, uneconomic units devoted to speculative cash crops rather than to livestock for which the land is best suited. To demonstrate this, and to encourage a return to the normal economy of the area, we are encouraging a program of unit reorganization. This involves usually a shift from wheat or some other cash crop to livestock, and the renting of additional land to round out an economic size unit. This frequently has to be done gradually as the land becomes available, but appears to be one of the most promising methods of bringing about rehabilitation of both land and families. Such plans naturally call for water for the livestock and usually mean *(Continued on page 196)*

Presented before the Soil and Water Conservation Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, December 1, 1938. Mr. Gordon is assistant director, rural rehabilitation division, Farm Security Administration.

Effect of Tire Wear on Tractor Performance

By E. L. Barger and J. Roberts

QUESTIONS being asked by the users of pneumatic tractor tires indicate that there are some problems in their minds as to what should be done when the tire tread becomes worn. Also, the tractor owner would like to know what can be expected in the way of tractor performance with worn tires. In order to answer these questions, some tests have been made at Kansas State College to determine the effect of tread wear on tractor performance on several different types of traction surfaces. These have been dynamometer tests and plowing and disking tests.

Two tractors (No. 1 and No. 2) were used in the tests. The tires used (Fig. 1) were all 9.00x36-in size. Tractor No. 1 was equipped with new tires with a height of tread of 1 in. Tractor No. 2 was equipped with new tires with a tread measuring 5/8 in in height. Tires with the tread worn practically smooth, were used on both tractors for comparison with the new tires mentioned. An inflation pressure of 15 lb was used in all tests. Tractor No. 1 had a static weight of 3600 lb on the rear wheels, including operator. Tractor No. 2, equipped as it was used in the tests, had a static weight of 3140 lb on the rear wheels. No attempt was made to make the weight on the traction members of the two tractors equal, since it was not the purpose of the tests to compare tractor performance.

Fuel consumption, time, draft, distance, and travel reduction or slippage were measured in all tests. The tractors were run in low gear in all dynamometer tests since it was desired to reach the maximum draft which the tires were capable of giving on any of the surfaces without stalling or overloading the engines.

Some new equipment and methods were used and a description of them may be of interest. A combination dynamometer car and loading machine, built at the College by the authors, was used to load the tractors. This machine (Fig. 2) built on a Ford V8 truck chassis, has a drawbar load capacity of 500 to 5,000 lb. The hydraulic dynamometer unit employs both direct-reading and recording instruments. The load is recorded on a strip chart driven by a ground measuring wheel which runs in the track made by the left front truck wheel. The chart area represents work. The load is obtained by throttling the discharge side of a gear oil pump which is driven through the truck transmission by the rear wheels of the loading machine.

The equipment used in measuring travel reduction is new; at least the authors have not found record of its being used before. A gage wheel (Fig. 3) was made up for each tractor drivewheel. A pipe sleeve, held by a setscrew, fits over the extended axle of the tractor to act as a bearing to carry the gage wheel. The gage wheel hub is another section of larger pipe, and to it are welded spokes of 1/2-in angle iron. The spokes are shorter than the radius of the tractor wheel by about 8 in. Springs extend from the spoke ends to the rim and give the flexibility needed for operation over uneven ground and to allow for the flexing of the rubber tires. The rim is a hoop of 1/4x1-in steel. One-inch spikes are welded into the rim. There are two adjustable or telescoping sections in the rim which permit adjustment of rim circumference to equal the tire circumference. A revolution counter, reading in revolutions and tenths of revolutions, is carried on the end of the sleeve fixed to the tractor axle. It is kept in an upright position by a linkage extended forward to a rod fixed to the tractor frame. This counter records the total revolutions of the tractor wheel. A ratchet-type counter is attached to the wheel hub, and the ratchet arm is operated by a setscrew in a ring which is a part of the sleeve fastened to the tractor axle. The ring is graduated so that the ratchet counter may be read to tenths of a revolution. The ratchet counter reads revolutions of the tractor drivewheel relative to the gage wheel.

In using the gage wheels it is necessary to make a calibration run on the ground on which tests are to be made with each set of tire equipment and inflation pressure used. This run is made at no load. The rim is adjusted so that it has a rolling circumference equal to the tractor tire. The ratchet counter then shows no movement relative to the

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers, at Chicago, Illinois, November 29, 1938. Contribution No. 89 from the Department of Agricultural Engineering, Kansas State College.
Mr. Barger (Mem. A.S.A.E.) is associate professor of agricultural engineering, and Mr. Roberts (Mem. A.S.A.E.) is instructor in agricultural engineering, Kansas State College.


FIG. 1 (LEFT) TRACTOR TIRES USED IN THE KANSAS TESTS. FIG. 2 (RIGHT) COMBINATION DYNAMOMETER CAR AND DRAWBAR LOADING MACHINE USED AT THE KANSAS ENGINEERING EXPERIMENT STATION

tractor axle. When the tractor is under load, any reading of the ratchet counter represents travel reduction. Per cent travel reduction is equal to $A/B\text{x}100$, where A is the revolutions difference between the gage wheel and the tractor drivewheel recorded by the ratchet counter, and B is the total revolutions of the tractor wheel recorded on the axle revolution counter. The calibration run may be used to determine a correction factor, if it is not desired to adjust the rim circumference to equal the tire circumference. The apparatus has been satisfactory in test work, and also it has desirable features for use in student laboratory tests and demonstrations.

Dynamometer tests were run on four types of traction surfaces namely, green grass, plowed ground, light stubble, and heavy stubble. The grass was of fairly heavy growth and the soil underneath was firm. The plowed ground was loose and dry on the surface but moist underneath. Wheat stubble which was thin and standing, and through which bare earth was easily visible, was considered as light stubble. The soil was mellow and fairly loose on top. The heavy stubble was down, matted, and covered with straw scattered by a combine. The soil under the heavy stubble was firm and moist.

Fig. 4 shows per cent travel reduction plotted against drawbar load for tractor No. 1, with new and worn tires on the different traction surfaces. A study of the curves shows the limitations of the worn tires on all surfaces. An abrupt change in slope of the curves for worn tires occurs in the range of 1600 to 1900 lb draft, slippage of the worn tires becoming excessive in that range. At loads up to 1600 lb the average of the travel reduction with the worn tires was less than with the new tires.

Fig. 5 shows the maximum drawbar loads obtained with the worn and new tires on tractor No. 1 on the various traction surfaces. The order of values with the two tractors was quite similar.

The unusually large drawbar pull obtained on green grass with new tires was observed to be due to the ability of the new tires with sharp tread to cut or shave off the grass and reach firm ground. The worn tires slipped on the grass after it was matted down. The result was similar with tractor No. 1 on heavy stubble. The new tires would rake off the straw and stubble, and permit the tire to reach bare soil, resulting in high maximum drawbar pull. There was very little difference between the new and worn tires on plowed ground.

The following table of traction coefficients (draft divided by total weight on traction members) of the different tires on the various surfaces offers another interesting comparison. The total weight on the tires was taken as the static weight on the rear wheels plus a calculated reaction due to the drawbar load. The value for draft used in calculating the coefficients was read from draft versus travel reduction curves at 40 per cent travel reduction.

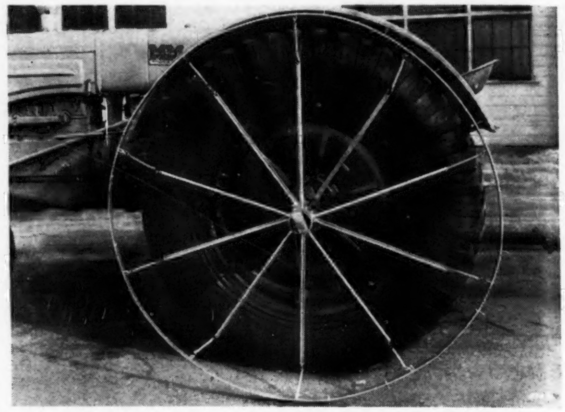


FIG. 3 GROUND WHEEL AND REVOLUTION COUNTERS USED FOR MEASURING TRACTOR DRIVEWHEEL TRAVEL REDUCTION

COEFFICIENTS OF TRACTION OF TRACTOR TIRES USED IN TESTS

	Green grass New	Green grass Worn	Heavy stubble New	Heavy stubble Worn	Light stubble New	Light stubble Worn	Plowed ground New	Plowed ground Worn
Tractor No. 1	.76	.45	.65	.42	.62	.50	.55	.54
Tractor No. 2	.74	.49	—	—	.69	.54	.61	.55

Figs. 6 to 11, inclusive, show travel reduction and fuel consumption at the full range of drawbar loads on the various traction surfaces.

Fig. 6 is for tractor No. 1 on green grass. The minimum fuel consumption is about the same with the new and worn tires, but the range of loads through which low fuel consumption was obtained with the worn tires is decidedly narrower than with the new tires. Fig. 7 is for tractor No. 2 on the same traction surface. There is similarity in the character of the curves in the two tests. The fuel consumption measured in pounds per horsepower-hour is influenced by two main factors. As the load is increased, the trend of fuel consumption is downward because a more efficient load is placed on the engine. As the load is in-

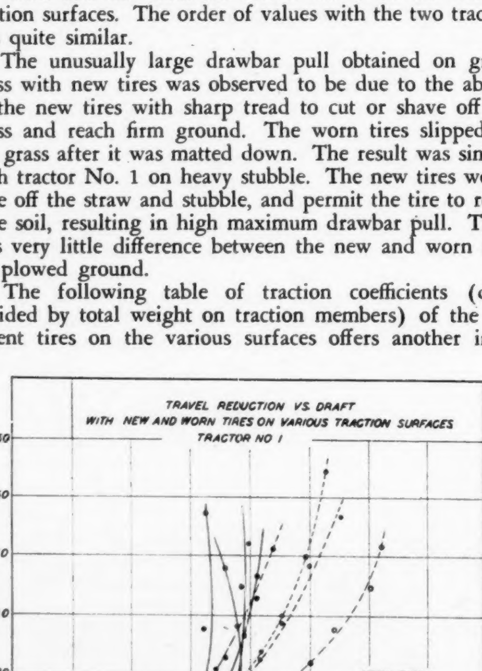
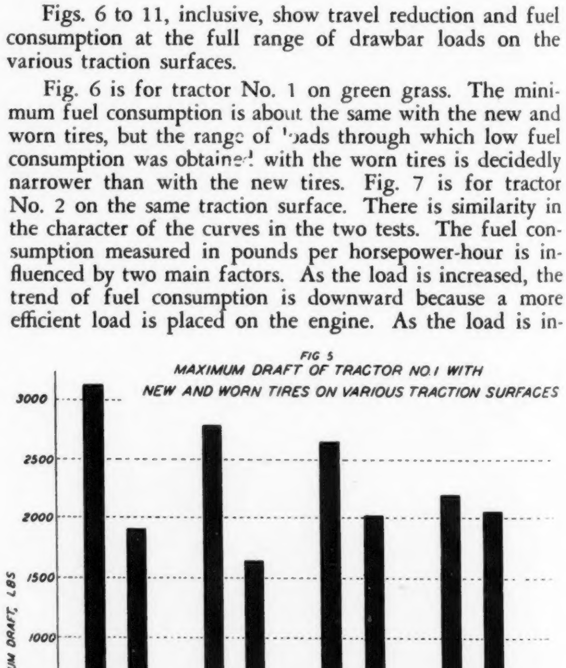


FIG 4



creased further, a point is reached where drivewheel slippage or travel reduction offsets the downward trend and causes the fuel curve to flatten out and then turn upward.

The performance of tractor No. 1 on plowed ground is shown in Fig. 8. As was pointed out earlier, there was less difference in performance with the new and worn tires on the plowed ground than on the other traction surfaces. The fuel consumption was less with the worn tires within the range of load and travel reduction common in field operation. Plowing and disking tests with this tractor, which will be mentioned later, showed similar results. The travel reduction with the worn tires was less until a 1950-lb load was reached which was near the limit for both sets of tires. Fig. 9 shows the results obtained with tractor No. 2

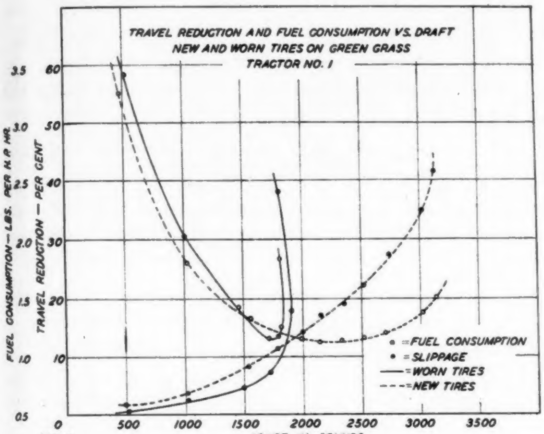


FIG. 6

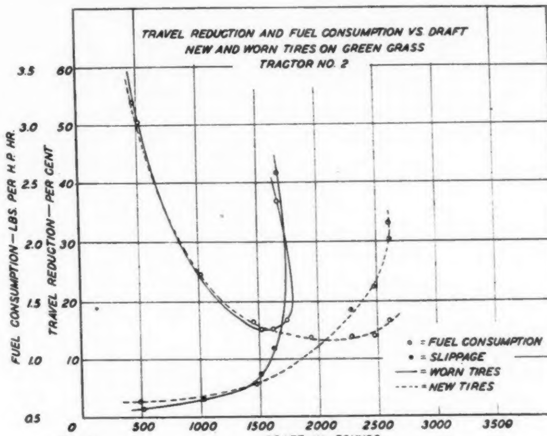


FIG. 7

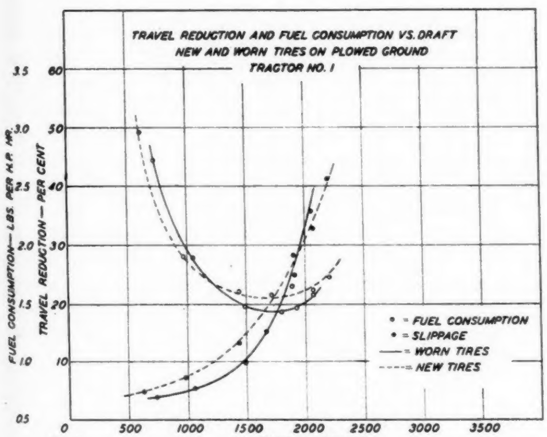


FIG. 8

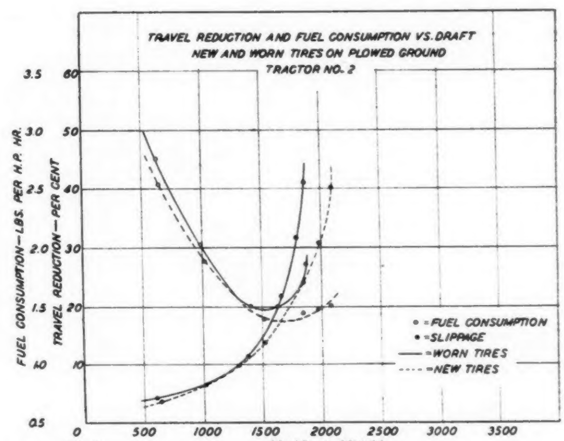


FIG. 9

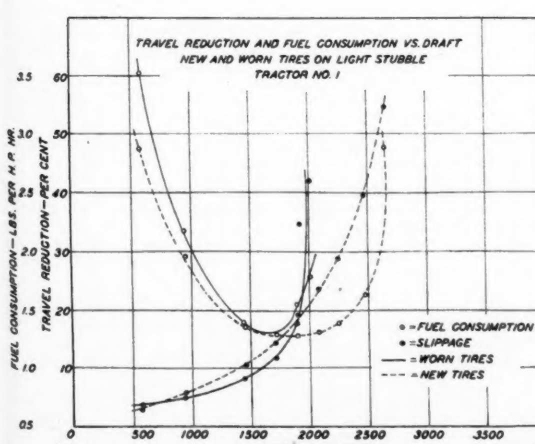


FIG. 10

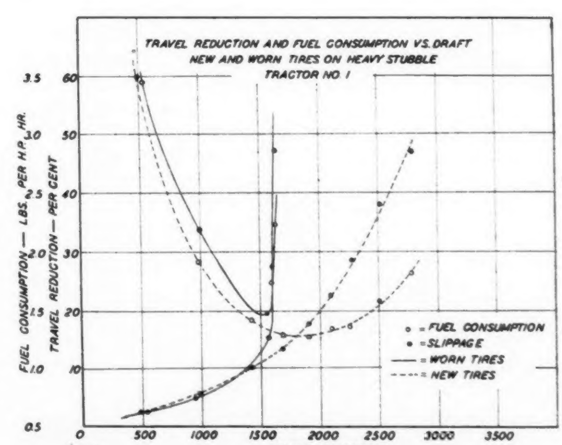


FIG. 11

in the same field. In this case the travel reduction of the worn tires was greater at drawbar loads of 1300 lb and above, and the fuel consumption curves show the effect of the greater slippage.

Fig. 10 shows the results with tractor No. 1 on light stubble. Here again the minimum fuel consumption with the two sets of tires is nearly the same, but the range of loads through which this low fuel consumption was obtained vary widely.

Only tractor No. 1 was tested on the heavy stubble and its performance is shown in Fig. 11. The curves are similar to those obtained on the green grass surface. The range of good performance with the worn tires was narrow. Maximum draft capacity of the worn tires was reached abruptly at about 1600 lb, while the new tires reached their limit at about 2800 lb. The significance of this contrast could be appreciated if you would imagine plowing with tires worn practically smooth in a field in which low spots were covered with heavy stubble and straw.

Field tests, plowing and disking, were run to try to obtain some correlation between actual field operation and the dynamometer tests. They were not run in sufficient number or on a wide enough variety of traction surfaces to be conclusive, but they show a trend that is indicated by the dynamometer tests. When plowing on wheat stubble ground with tractor No. 1, the fuel consumption with the new tires was 13.55 lb per acre, and with the worn tires, 13.35 lb per acre. Travel reduction with the new tires was 10 per cent, and with the worn tires 10.8 per cent. Average draft of the plow was 1350 lb. The same tractor was used to pull a 15-ft single-action disk harrow on dry, hard kafir stubble ground. Disk penetration was slight and draft was 830 lb. Travel reduction was 6.1 and 3.7 per cent with the new and worn tires, respectively. Fuel used per acre was 1.88 lb for the new tires and 1.86 lb for the worn tires. A part of the same field was covered with a light application of manure. Disk tests on it gave less penetration and draft of only 780 lb. The fuel consumption was 1.86 lb per acre for both sets of tires and the travel reduction was 5.3 per cent with the new tires and 3.42 per cent with the worn tires.

The limited capacity of the worn tires was brought out well in the plowing tests. A test was started with the new tires on the tractor and the plow was adjusted to the desired depth. Half of the plot was plowed and then the worn tires were put on to complete the plot. The worn tires would not pull the plow and that test had to be abandoned and another test started at a plow setting that the worn tires could handle.

SUMMARY

1 The maximum draft obtained was less with worn tires on all traction surfaces.

2 The drawbar load at which lowest fuel consumption was obtained was influenced by the condition of the tire tread.

3 The range of loads through which low fuel consumption can be obtained was wider with new tires.

4 At light to medium drawbar loads the fuel consumption with worn tires was no greater than with new tires.

5 Within the range of normal farm operation on field soils, the worn tires will still give good performance.

6 The limitation in maximum draft with worn tires on a few traction surfaces will probably be the chief factor prompting the tractor operator to take some action when his tractor tires become worn.

It is not possible to state at this time what the solution to the problem will be. An increase of wheel weight may be partly effective in overcoming the decreased traction of worn tires. Retreading is a possibility, with the tire companies equipped to do retreading of tractor tires at their factories and a very limited number of service stations in the field equipped to retread tractor tires. There were a few cases last summer of farmers buying new tires for their tractors and shifting the worn ones to combines and other implements. One tire company reported an active demand for "trade-in" worn tractor tires by farmers who wished to use them on combines. The tractor tire, sound in structure but with the tread worn, still has an economic value, and both farm experience and special research will be required to determine how the greatest returns may be obtained from these tires.

Stressed Plywood Coverings for Poultry Brooder Houses

(Continued from page 189)

sun's rays readily and further insulation or ventilation would be necessary to keep inside temperatures low on warm sunny days.

4 Glued plywood construction reduces air infiltration to a minimum.

5 Plywood 5/16 in thick can be easily bent to the 5-ft 6-in radius used in these houses but requires headers at the ends of the sheets.

6 Brooder houses of plywood over laminated bent glued rafters can be made light in weight and at the same time strong and rigid.

7 Plywood gusset plates appear to be an effective means of fastening structural members.

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AUTHORS' NOTE: Acknowledgment is made of the cooperation of Dr. H. L. Wilcke, head of the poultry department, Iowa State College.

A Method of Measuring Runoff Velocity as Related to Soil Movement Between Terraces

By E. G. Diseker

A REVIEW of the literature revealed very little information pertaining to the velocity of water and its erosiveness in the sheet erosion process. Neither did the literature give a suitable method for measuring the water velocity and soil movement in sheet erosion between terraces.

The velocity of runoff water from a natural rain flowing across the soil under field conditions cannot be measured in the same manner as the velocity in pipes or open channels, because of an added amount of water falling along the entire slope length. As the water is accumulated down the slope, the velocity is increased. The depth of this moving sheet of water is difficult to measure. The float method did not seem advisable because of the thinness of the sheet of water, the irregularities of soil surface, and the obstructions which exist under field conditions[1]. Addition of coloring matter to the thin sheet of water was not advisable because of the adsorption of the dye by the suspended solids and the turbidity of the water[2, 3].

Presented originally before the Southern Section of the A.S.A.E., meeting in conjunction with the Association of Southern Agricultural workers, at Nashville, Tenn., February 4, 1937. Revised and brought up-to-date for publication in AGRICULTURAL ENGINEERING. Mr. Diseker (Mem. A.S.A.E.) is assistant professor of agricultural engineering, Alabama Polytechnic Institute, and assistant agricultural engineer, Alabama Agricultural Experiment Station.

Superscript numerals refer to literature cited following text.

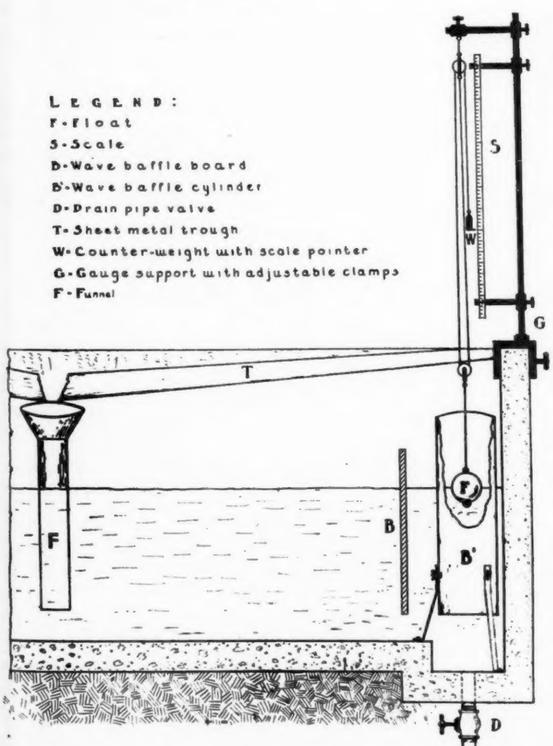

FIG. 1 SKETCH OF CISTERN WITH APPARATUS FOR MEASURING THE RATE OF RISE OF RUNOFF WATER

Since no distinction for terrace spacing with respect to soil type has been made, it is the purpose of this paper to discuss a method for measuring the runoff velocity and related soil movements between terraces as a basis for terrace spacing.

In this experiment measurements were made to determine the rate of water runoff and the soil losses in order to calculate the apparent slope velocity. The apparent slope velocity is only approximate in that the runoff rate varies according to obstruction on the plots. The water may pond up in depressions and then break through, or it may flow around obstructions, and, as a result, the time of concentration at the lower end of the plot is erratic.

The experimental area consisted of four pairs of partially controlled plots of representative Cecil clay. The plot slopes were 5, 10, 15, and 20 per cent. Each plot was 1/58 acre, 50 ft long and 15 ft wide[4].

Tests were conducted on 50 and 25-ft plot-lengths having slopes of 5, 10, 15, and 20 per cent. Each slope and each slope length was tested on freshly plowed plots; firm, smooth fallow plots; on plots planted to oats in 10-in contour rows; and on plots planted to Austrian winter peas in 18-in contour rows. After completion of a test on a full plot (50 ft), a test on a half plot under identical conditions followed immediately. Only two slope lengths were used, as previous tests showed that the time variation of runoff concentration was slight for 12½-ft slope length with the apparatus used. The same plot for the 25 and 50-ft slope lengths was used for a particular condition because the companion plots were in different crops and tillage conditions.

The rate of artificial rain used on these tests was 6.8 acre-inches per hour for a period of 6 min. The rain was applied by a modified Skinner irrigation system[4]. An attempt was made to eliminate the saturation variable by slowly wetting each plot before each test. A ¾-in pipe equipped with Skinner side-spray nozzles, spaced 12 in apart, was used to saturate the plots to a depth of approximately 10 in. By applying the water slowly for a period of 6 to 10 hr, runoff was eliminated.

The apparatus used to measure the rate of runoff from artificial rain consisted of a special float gage with "frictionless" pulleys counterbalanced with weights (Fig. 1). By means of this gage the rise of water in the cisterns was recorded on a chart at 15-sec intervals; a permanent record was made by marking the chart as the pointer moved downward. The pulleys were arranged on the gage so that the chart would show twice the actual depth of runoff in order to reduce errors in observation. The float was baffled to prevent wave action. To eliminate further wave action a 6-in water blanket was placed in the bottom of each cistern at the beginning of each test, and the 6-in pipe through which the runoff water flowed extended beneath the surface of the water.

One-half gallon samples of runoff water with its suspension load were taken at one-minute intervals. The soil in these samples was precipitated and the water was decanted. The soil was then dried in ovens and the rate of soil movement was calculated from these samples.

The rate of runoff was measured by the rate of rise of water in calibrated cisterns. Successive differences in the rises on the chart per 15-sec interval were taken to indicate the runoff rate. A curve was plotted from these differences, the abscissa representing time in 15 sec per reading and the ordinate cubic feet of runoff per 15 sec. A runoff rate curve is shown in Fig. 2. From this curve the time at which maximum runoff occurs can be approximated. The velocity in feet per second was calculated by dividing slope-length in feet by time in seconds from the beginning of the test until maximum runoff occurred.

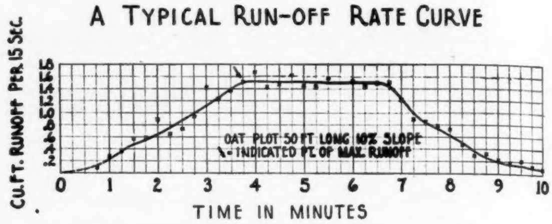

FIG. 2 RUNOFF RATE CURVE WHICH INDICATES THE TIME FOR MAXIMUM RUNOFF RATE TO OCCUR

DISCUSSION

In general, the greatest soil losses occurred during the first increment of rain; this was due to a certain amount of slaked or loose soil that was easily washed off the plots. For this reason, consecutive tests on the same plots will not give comparable erosion losses.

Curves plotted of velocity and soil losses for the different plot-slope conditions revealed that losses increased when the velocities increased, but varied to such an extent that no specific relation could be obtained from the curves. This was true because of the fact that in many instances the rate of losses increased rapidly when velocity increased, but during the next increase of velocity the rate of soil losses decreased. This shows that the rate of soil movement is dynamic and may be explained as follows: The soil that is loose or in a comparatively erodible state may be carried off by the first increment of runoff or partially deposited in the lower portion of the slope and then carried off by the next increment of runoff. In some cases it may require considerable time for the rain to loosen the soil before it can be moved. At times the soil is in a loose state, but the surface is irregular and the runoff water will fill the depressions with soil before appreciable soil is lost.

The tests revealed that in two instances the velocity was doubled when the slope was increased four times, in which case the soil movement was increased about fifteen times. This occurred on 50-ft slope lengths of oats and winter pea plots. On the freshly plowed plots (50-ft slope length) the velocity on the 20 per cent slope was 1.3 times greater than on the 5 per cent slope and the movement of soil 7.6 times that on the 5 per cent slope.

Velocity of water flowing across a uniform slope of soil reached a constant under any set of conditions after the maximum runoff occurred, but the time required to reach the maximum runoff depended on the condition of the surface of the soil and crops grown. This is based on the fact that the runoff rate will finally approximately equal the rate of rainfall.

It appears that the method developed is applicable for measuring runoff and calculating slope velocity as related to soil movement, but will require refining before highly accurate data can be obtained. For instance, the cross section of the cisterns in which the runoff water is caught should be extremely accurate, which was not the case with the cisterns used.

The mechanism for measuring the rate of rise in the cisterns should be more sensitive than the one used in order to eliminate part of the lag which was present (Fig. 1). The lag caused by the time necessary for the water to travel a distance of 7½ ft to the down-spout and then drop into the cisterns, a distance of about 4 ft, and then again travel a horizontal distance of 7½ ft to the float gage, and also the meniscus effect of the water rising up the cistern walls, will be difficult to eliminate.

Representative samples of runoff water with its suspended load were difficult to obtain by placing ½-gal jars under the runoff spout, as a mere fraction of time would greatly influence the amount of soil caught in the samples.

The process of soil movement is dynamic and considerable study will have to be made before the present recommendations for terrace spacing can be changed.

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The Relation of Water Facilities to Agricultural Relief and Adjustment

(Continued from page 190)

wells and stock tanks in sufficient number to make the most efficient use of the range, and frequently flood irrigation or irrigation from wells for forage and feed crops to supplement the range.

In the early days of the rehabilitation program, as an agency set up to meet an emergency situation, we were inclined to try to work out our program and methods on an emergency basis. As the program develops and we see it growing into a permanent program, proving the job can be done on an almost completely self-liquidating basis, we realize that emergency methods must be discarded, and the problem met upon a permanent, long-time basis which fully takes into account the fundamental causes back of the problem. Corrective measures must be worked out slowly but surely on a basis that will pay its way. In the arid states, water must necessarily play a large part in the solution of the problem, as all too frequently it is the largest single limiting factor.

It is our hope that the water facilities program will meet a real need that has not been met heretofore, and that it may be set up from the beginning on a sound and effective basis, proving itself as it goes. There is no occasion for conflict with other water programs and we hope to keep it on a basis that will contribute to the small operator whose need is great and whose resources are small, making it truly contribute to the rehabilitation of both man and land. The job calls for careful, farsighted planning, both by areas and for individual units, for efficient operations to keep the cost in line with returns, and for wise and sympathetic loan servicing and guidance in carrying out plans. Your sympathetic interest and your suggestions and constructive criticism are solicited at all times. The job is big enough to challenge the best thinking and united effort of us all.

Engineering in Soil and Water Conservation

By V. R. Hillman

NO ONE questions that engineering—more specifically, agricultural engineering—has an important place in any well-planned soil and water conservation program. It is not my purpose either to justify or defend engineering in such a program, but rather to outline some of the major responsibilities of engineers in connection therewith. No justification or defense is necessary before this group, but it is always in order to take stock of ourselves and our plans, and to define our position and purpose, even to ourselves.

In an erosion-control program, the problem is primarily and fundamentally engineering rather than strictly agricultural. It is fundamentally an engineering problem because it is so closely and inseparably associated with hydraulic and mechanical factors that, unless we approach it with a reasonably accurate appreciation and understanding of these factors, we are hopelessly lost in arriving at any adequate and permanent solution. Flowing water and movement of soil are purely physical and mechanical processes. They are caused, and may be controlled, only by influencing the physical and mechanical factors involved. These hydraulic and mechanical factors require engineering analysis and treatment, whether or not a particular analysis is made and the treatment is given by trained engineers, or by agronomists, foresters, or by any other technical group. Obviously, the agricultural engineer, by reason of his training and experience, is the technician most logically qualified to analyze these hydraulic and mechanical features. If he avoids the problem, is unable to handle it, or is not permitted to do so, then someone else must attempt a solution as best as he can.

Only a few of the many angles of the problem that concern the engineer and engineering analysis will be mentioned.

Rainfall is one of the first that might be considered. Virtually nothing can be done to influence either rate, amount, or distribution of rainfall. But rainfall does not cause erosion. Erosion is caused by that part of rainfall that is permitted to escape as surface runoff. Naturally a thorough study must be made of rate, amount, and distribution of rainfall in an effort to determine the separate and combined effects of these factors on runoff, as well as their effect on crops and cultural practices. There are still many unanswered and partly answered questions on this phase of the problem, and extensive research and investigation is being conducted in order to answer these questions more intelligently. It is important, however, that operations men make more diligent use of data and information that is available. These should be studied and correlated with the best information on hydrology and hydraulics, in order to effect a reduction in the amount of runoff and to control and minimize the damaging effects of the runoff. Although all soil conservation workers are interested in and concerned with this phase of the problem, such analysis does more particularly concern the agricultural engineer.

There are scores of other factors of equal or greater importance in the fields of soils, agronomy, and forestry, and a thorough knowledge of them is most essential. Many of these are not of primary concern to the engineer, but he must have some knowledge of each in order to make his own work effective. Also, it is true that many of these factors may appear to be mainly agronomic or forestry problems, but on closer observation involve engineering primarily. For example, take vegetation. Vegetation is recognized as the most important single factor in the entire erosion-control problem. Vegetation may be primarily an agronomic material, but look at it a moment from an engineering point of view. Vegetation, regardless of its nature and ultimate use, performs three most important functions in so far as protection of the soil and conservation of moisture are involved:

1 Good vegetative cover, both as growing plants and as crop litter and residue, protects the surface soil from the beating action of heavy rainfall, and from excessive heating and evaporation on hot, sunny days.

2 Root systems mechanically bind the soil particles together and help them resist the erosive action of flowing water.

3 Plant food elements, decaying vegetal matter, and soil organisms contribute to the chemical and mechanical nature and structure of the soil so as to increase its water retention capacities and thus reduce the amount of runoff, as well as making the soil more resistant to erosion.

These are purely mechanical functions performed by vegetal material. If a crop or cover is considered in the erosion-control program entirely from the agronomic angle, without proper regard to its engineering and mechanical aspects, we most certainly will be inviting trouble. We must take advantage of vegetative protection at every opportunity, but when it must withstand the effect of flowing water, its qualities and limitations in this regard must be carefully considered. Qualities not ordinarily considered in regular agronomic work may be controlling features in the use of vegetation exposed to flowing water. Flowing water does not follow agronomic or agricultural laws, but purely hydraulic and mechanical laws. Vegetation for use in waterways must not only thrive under the local soil and climatic conditions, but its water-carrying ability must be evaluated and designs provided only after careful consideration of this ability and the requirements to be imposed upon it. It is a definite responsibility of the engineer to assist in such analysis and evaluation, and to consider vegetation in this connection the same way he would any other engineering material.

In speaking of the mechanical features in soil and water conservation, we have suggested that the whole problem is fundamentally more engineering than it is agricultural. There appears to be no reasonable doubt as to the accuracy of such a statement; however, when considering the actual means and the method of attack in the field, use is made of every known and proven practice in land-use planning, farm management, soil science, agronomy, forestry, and wildlife management, as well as the more strictly mechanical or engineering features of control. This presents wide latitude for each individual to exercise his best knowledge and experience in his own specialized field. It is an agricultural engineer's responsibility to gain all the knowledge he can in each of these related fields. It is more important,

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Presented before the Southern Section of the American Society of Agricultural Engineers, at New Orleans, La., February 1, 1939. Mr. Hillman (Mem. A.S.A.E.) is area conservationist, Soil Conservation Service, U. S. Department of Agriculture.

however, that he cooperate with each and coordinate and use his engineering training and experience along with the specialized training of all other technical personnel in determining the best solution of the problem at hand.

It is probably not appropriate here to go further into the matter of cooperation. However, it might be suggested that the agricultural engineer, by virtue of the very nature of his profession, is or should be a specialist in cooperation. Just as an engineering structure is not usually in itself the final result to be attained, but rather the service it renders for a special purpose, so agricultural engineering is not an end in itself but only a means to more efficient production, less arduous labor, more accurate treatment, or other contribution to better practice. In the erosion-control program this is certainly true. Any engineering treatment is of value only to the extent that it contributes to the best interest of the most appropriate land-use or water-disposal plan.

Another problem facing the engineer in this program of soil and water conservation is that of soil relationships. There are many factors in this connection and different technicians may view these differently. The agronomist, for instance, is probably most interested in soil and crop relationships, as regards adaptability, fertility level, etc. The soil technologist or geologist may think primarily of soil classification, as regards origin, composition, or its various physical characteristics. Present soils classifications are mainly on this basis and such information is of value. The erosion-control engineer, however, is concerned primarily with water and soil relationships. How does a particular soil react to water, both internally and on its surface?

The accurate classification of soils on this basis will serve a most useful purpose, and such a classification would meet the requirements of technicians other than the erosion-control engineer. Such a classification should be applicable to every phase of agricultural engineering, as it would be a measure of soils as to their resistance or susceptibility to erosion by water or wind; their ability to prevent seepage, as in dams or ponds; their permeability as in drainage; their supporting capacity for foundations; their reaction to tillage tools and tillage operations; their tractive characteristics, and others. It is most probable that the same fundamental factors, such as texture and degree of aggregation, are the determining factors in a classification that would serve all the foregoing uses. If this is true, a classification of this nature can readily be accomplished, and it will be of great value to the agricultural engineer in most, if not all, of his design and application problems.

This is not to say that some such information is not now available and being used, but it does appear that research-minded agricultural engineers and soils technicians might work out a more definite classification along this line that would prove of great value to soil science, as well as provide a valuable tool for many technicians.

There is another angle to this matter of the relation of engineering to the entire soil conservation problem that I would like to mention briefly. It has to do with professional attitude and professional responsibility, and applies equally to other professional groups as well as engineering, and to fields other than soil conservation. The younger men are more likely to fall into error in this regard, but none of us are entirely immune. Many of us think of engineering almost entirely in terms of building a structure. That is not engineering, but simply construction. The engineering is in the selection of the type of structure for the particular purpose, the selection of appropriate materials and correct design of the structure, and in the necessary engineering supervision and inspection to insure that the finished structure comes up to the standard of excellence required. Actual building of a structure is not engineering, sowing wheat is not agronomy, nor planting a tree forestry, any more than patching a leaky roof is architecture.

It is true that we want engineering supervision and inspection, and we probably should have more than can readily be supplied, but many times there appears to be a neglect in preliminary planning, and efforts are then made to correct faulty plans or lack of plans by close attention to details in the field. This is by no means an indictment against the man whose job is in field layout and supervision, but if field details are consuming more than their appropriate share of the time of professional men, to the end that insufficient over-all planning is being done, then a rearrangement of time should be effected.

Technical and professional men must be ready and able to accept responsibility, but it is often more important, and frequently more difficult, to find the man that can or will delegate responsibility properly and effectively. Before responsibility in field operations can be delegated, it is essential that the necessary instructions and information be conveyed to subordinates in such a manner that they can be readily understood and carried out. This is a part of planning and organization. So far as an engineering job is concerned, if I can be assured that the design is correct, that it is clearly and accurately shown in the plan and specifications, I am not so concerned as to who executes it. He may be an engineer, an agronomist, or a grocery clerk, so long as he can handle the men and materials necessary to the job and is able and willing to follow instructions. I don't believe it requires a forester to plant a tree, an agronomist to sow lespedeza, nor an engineer to build a check dam. If so, the average farmer is in a most unfavorable position to carry out a soil and water conservation plan prepared for his farm, especially if that plan is so technical, or so lacking in clarity that a trained technician is needed to execute it.

Costs and Values in Rural Housing

By Deane G. Carter

THE CWA housing survey conducted in 1934 indicated that a majority of farm homes in Arkansas were in need of extensive repair and remodeling; few were equipped with water supply, plumbing, sewage disposal, and electricity, and a definite need was shown for more adequate room and storage facilities[1].

Census records (1930) indicated the average value per farm house in the state as $389. A grouping of the census data by counties indicated housing values ranging from $330 to $770 per farm. Highest values were shown in counties that had the largest proportion of ownership and the highest land values per farm. On the basis of this information, and some observation, it was assumed that the housing condition was basically a result of the economic situation, and that little improvement could be expected, except through a program that offered some values as a substitute for cash expenditure.

Research paper No. 635, Journal Series, University of Arkansas, released for first publication in AGRICULTURAL ENGINEERING. Mr. Carter (Fellow A.S.A.E.) is professor and head of the agricultural engineering department, University of Arkansas.

[1]Carter, Deane G., Arkansas Farm Housing Conditions and Needs, Ark. Agr. Exp. Sta. Bul. 305 (1934).

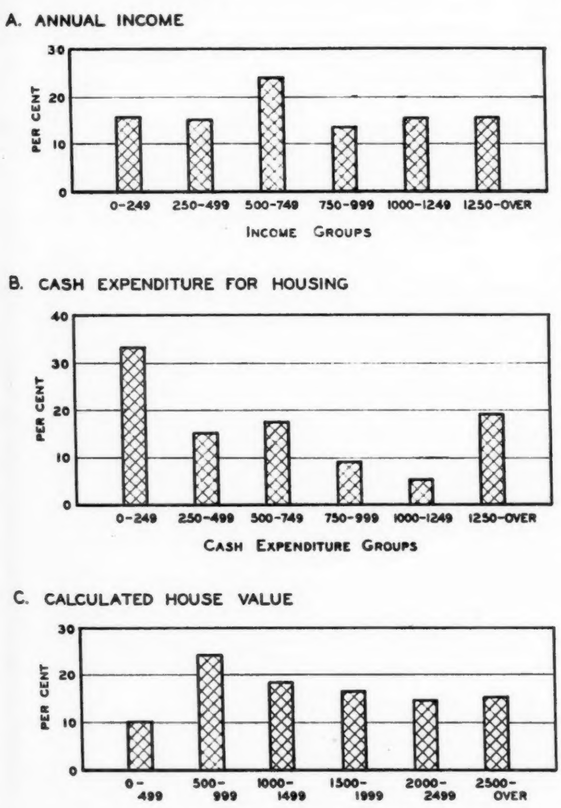


FIG. 1 PERCENTAGE DISTRIBUTION OF RECORDS OF ANNUAL INCOME, CASH EXPENDITURE FOR HOUSING, AND CALCULATED VALUE OF HOUSES, 214 RECORDS, ARKANSAS, 1938

Abundant natural resources are available in the state, in the form of logs, poles, rough-sawn lumber, sand, gravel, and stone. Ample labor may be secured on the farm, or in the community, at reasonably low wage rates.

A housing program was initiated by the University of Arkansas College of Agriculture late in 1937 based upon a "campaign" to utilize local labor and native materials for cash cost reduction[2]. In this connection, records were obtained covering 214 farm houses, built with a "home contribution" of labor and material. Sufficient data were secured to indicate the value of the home contribution to housing, typical costs, and the relation of housing to annual income[3]. The records covered a satisfactory range of location and materials used, and were quite typically distributed according to cost, farm income, and completed value (Fig. 1).

The houses covered by the study averaged 961 sq ft of finished area, 4.68 rooms per house, with 3.8 occupants each. The average cash expenditure was $740, with a median of $500. The calculated value of the completed houses was $1,575 each, with a median of $1,320. Annual income per farm averaged $785, with a median of $550.

Value of Home Labor. The average labor value was $520 per house, or 33 per cent of the calculated value of $1,575. The cash expended for labor averaged $176; therefore, the value of the home labor utilized was estimated at $344 per house. The unweighted average of the home labor utilized in housing was 66.2 per cent of the total labor. Nearly one-half of the families supplied 75 per cent or more of the labor required. In 44 cases of low-cost housing, no expenditure was made for labor. A house built by the College of Agriculture, as a part of the study, required approximately 1280 hr labor, of which 700 hr, or 54.5 per cent, was unskilled.

Value of Native Materials. The calculated value of the materials used was $1,055 per house. The cash expenditure for materials was $524, and the estimated value of contributed materials was $531[4]. This contribution consisted principally of stone, logs, sand, and gravel, obtained usually at no cost except labor; rough-sawn lumber from farm timber; and miscellaneous materials such as hand-riven shingles, sawdust insulation, and hand-finished trim. In a few cases, farmers exchanged labor for lumber, or traded logs for lumber. Less than one-fifth of the material cost was for the heavy or bulk materials, and principal expenditures were for millwork, flooring, roofing, paint, and equipment. Log walls were found in 26.8 per cent of the houses studied, and 32.4 per cent had stone walls.

Quality of Housing Obtained. It was evident that the savings in material and labor enabled the owners to spend a greater proportion of available cash for mechanical equipment and other qualities of improved housing. At an average cash cost of $740, and a medium cost of $500, the quality obtained was well above the average of the white

[2]Carter, Deane G., A State-Wide Farm Building Program; Agr. Eng. Vol. 19, No. 2 (Feb. 1938).

[3]Carter, Deane G., Study of Rural Housing; Ark. Agr. Exp. Sta. Bul. 364 (1938).

[4]The analysis of cash costs for material and labor separately are based upon 190 records which were complete in detail, which show cash expenditure of $700, or somewhat less than the $740 general average.

owner's homes in the state. Table 1 indicates that these houses were less "crowded", slightly larger, and far better equipped than the average.

The range of quality represented by the houses in this study is indicated by the data as grouped in Table 2. In general, the highest qualities are represented by 23 houses that included complete plumbing as a part of the construction, and the lowest qualities are found in 44 houses built entirely with home labor. The third column indicates averages for the entire group of houses.

Income and House Size. The size of the house increased almost directly with annual income (Fig. 2). The houses in the lowest income group averaged 3.65 rooms, while those in the highest group averaged 5.51 rooms per house.

Income and Expenditure for Housing. From 173 cases for which annual income and cash expenditure records were obtained, the average cost for housing was $45 less than one year's income. In nearly one-half of all cases, the cash expenditure was in the same group as annual income (as, for example, $500 - $999).

Unit Costs and Values. The entire cost of construction for typical well-built, modern rural homes, under Arkansas conditions, is from 14 to 18 cents per cu ft. Usually such houses do not have central heating systems, and are wood-ceiled rather than plastered. A typical five-room house was built by the College of Agriculture in 1938, intended to represent as nearly as possible the size, type, and quality of houses in the study. The cubic unit cost was 9.4 cents per cubic foot.

The calculated value for the houses studied was 11.1 cents per cubic foot, of which 5.2 cents was for cash outlay, and 5.9 cents for the value of home labor and native materials. The calculated value, based upon data accumulated by the department of agricultural engineering, is somewhat less than the owner's estimate of value (Table 3).

TABLE 1. COMPARISON OF HOUSING QUALITIES FROM 214 RECORDS, WITH THE STATE AVERAGE OF WHITE OWNERS HOMES

Item	214 houses (in present study)	White owners (1934 survey)
House size (rooms)	4.68	4.60
Occupancy (persons)	3.80	4.37
Crowded (per cent)	16.00	28.00
Stone or log walls (per cent)	59.20	6.00
Kitchen sinks (per cent)	49.50	9.25
Indoor toilets (per cent)	18.20	2.70
Electricity (per cent)	21.40	8.50
Screened (per cent)	95.00	80.70

TABLE 2. COMPARISON OF HOUSING QUALITIES FOR HOUSES WITH COMPLETE PLUMBING, HOUSES BUILT ENTIRELY WITH HOME LABOR, AND THE ENTIRE GROUP

Item	23 houses with complete plumbing	44 houses built with home labor	214 houses (entire group)
Annual farm income (dollars)	1,162.83	605.00	785.00
Cash cost of house (dollars)	1,736.74	134.00	740.00
Calculated house value (dollars)	2,741.00	862.00	1,575.00
Proportion cash cost to total value (per cent)	63.20	15.50	47.00
Proportion home labor (per cent)	33.00	100.00	66.20
Kitchen sinks installed (per cent)	100.00	19.00	49.50
Indoor toilets installed (per cent)	100.00	0.00	18.20

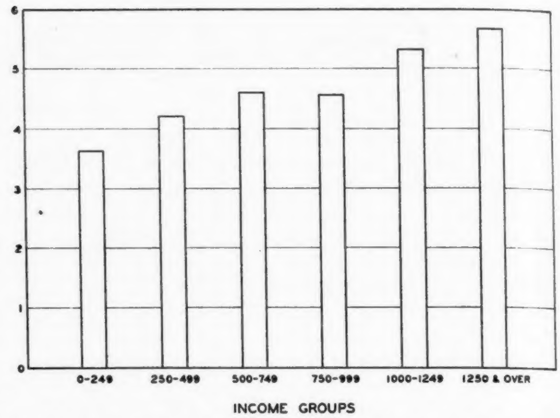


FIG. 2 HOUSE SIZE BY NUMBER OF ROOMS, ACCORDING TO INCOME GROUPS. HIGHER INCOME FAMILIES TENDED TO BUILD LARGER HOUSES

SUMMARY AND CONCLUSION

1 An investigation of housing conditions, needs, and incomes indicated that Arkansas homes could be improved in quality only by the substitution of other values in lieu of cash.

2 A study was made of 214 houses built with a contribution of home labor and material resources to reduce the cost. Although considerable variation occurred in individual cases, the averages, medians, group distributions, and cost data are comparable to other research data obtained by the author.

3 The average cash expenditure per house was $740 (on 190 records, $700); annual income per farm, $785, average value of contributed labor and material, $875; and the calculated total value per house, $1,575.

4 Principal non-cash contributions consisted of home labor valued at $344 and native materials valued at $531 per house.

5 The conservation of cash resources enabled the owners to obtain much higher quality housing than the average of the white owners of the state.

6 The annual income of the farm is a major factor in quality of housing. At the higher income levels more equipment was installed, houses were larger, a greater cash expenditure was made, and less home labor was used.

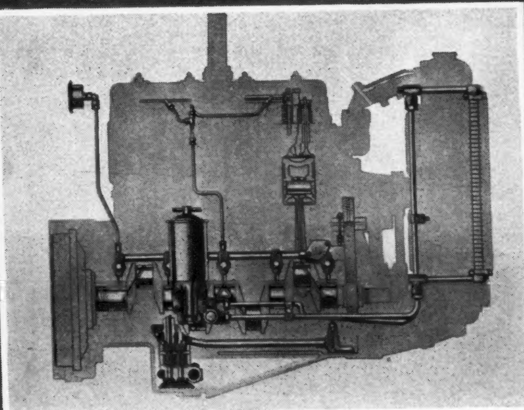
7 The average unit values of the houses studied were 11.1 cents per cubic foot, $1.64 per square foot, and $332 per room. The cash cost was 44.4 per cent of the total value, and the home contribution was 55.6 per cent.

TABLE 3. AVERAGE COST AND CALCULATED VALUE PER HOUSE, PER ROOM, PER SQUARE FOOT OF GROUND FLOOR SPACE, AND PER CUBIC FOOT OF CONTENTS (209 RECORDS)

Cost or value	Total Dollars	Median per house Dollars	Average Per house Dollars	Average Per room Dollars	Average Per square foot Dollars	Average Per cubic foot Cents
Calculated value	329,165	1,320	1,575	332	1.64	11.1
Cash outlay	154,461	500	740*	157	.77	5.2
Value of home contribution	174,404	820	835*	175	.87	5.9
Owner's estimate of value	364,392	1,200	1,745	366	1.82	12.3

*On 190 records calculated separately for labor and material values, the figures were $700 and $875.

DIESEL ENGINE OIL COOLING AS DEVELOPED BY "CATERPILLAR"!



This sectional drawing shows the engine lubricating system of the "Caterpillar" Diesel D2 Tractor. The oil cooler is located directly in front of the water radiator, where most effective cooling is obtained. Developed by "Caterpillar" engineers — especially for use on "Caterpillar" Diesels — this refinement has been proved by use to produce these results:

(1) Maintains an engine lubricating oil temperature 30° to 45° F. above atmospheric temperature.

(2) Supplies oil to the bearings at a temperature 40° to 50° lower, than does the system without a cooler.

(3) Materially increases bearing strength by maintaining the lower temperatures.

(4) Retards oil deterioration because of lower temperature, and also maintains the viscosity within a narrower range, for proper circulating and lubricating qualities.

(5) Permits employing a lower viscosity oil — avoids undue wear in piston rings and cylinder liners, even during the warm-up period, by assuring thorough engine lubrication at low starting temperatures. This means easier starting and constant protection of moving parts.

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DIESEL ENGINES TRACK-TYPE TRACTORS TERRACERS

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NEWS

Annual Meeting Program Features Announced

FOLLOWING a plan of recent years which has met with general approval, the A.S.A.E. annual meeting at St. Paul, June 19-22, will start with a College Division day, continue with two mornings of two-hour general sessions followed by technical division sessions, and end with a day devoted exclusively to technical division interests. Except for the first day, afternoons and evenings are held open for inspection trips, committee and special group round tables, other special meetings, and entertainment.

GENERAL SESSIONS

William Boss will formally open the meeting at the first general session and call upon Dr. W. C. Coffey, dean of agriculture at the University of Minnesota, for a brief address of welcome. S. P. Lyle is then to give the president's annual address. An address by Dr. H. G. Knight, chief of the U. S. Bureau of Chemistry and Soils, is to bring this session to its climax. This inspirational presentation of realities and opportunities in terms of the significance of agricultural engineering work is calculated to vitalize the several technical sessions immediately following.

Headliners of the second general session will include Dr. S. C. Lind, dean of the Institute of Technology, University of Minnesota, with an address on "Engineering in Agriculture"; Frank. J. Zink on "Engineering Aspects of Equipment Needs for Small Farms"; and Wm. A. Bennett, a Minnesota farmer, giving "A Farmer's Viewpoint on Farm Structures."

S. P. Lyle, as president of the Society, will preside over the general sessions. Division chairmen and vice-chairmen will share duties in presiding over the various division sessions. They are, in the Power and Machinery Division, F. P. Hanson, chairman and E. M. Mervine, vice-chairman; in the Farm Structures Division, J. D. Long, chairman, and E. D. Anderson, vice-chairman; in the Rural Electric Division, B. P. Hess, chairman, and R. R. Parks, vice-chairman; in the Soil and Water Conservation Division, M. R. Lewis, chairman, and Ray W. Carpenter, vice-chairman; and in the College Division, B. B. Robb, chairman, and F. W. Duffee, new chairman.

Special entertainment for the wives and children will be provided for the hours when the agricultural engineers are occupied in technical sessions.

Meeting preliminaries scheduled for Sunday, June 18, include registration, from 1:00 to 8:00 p.m., a Council meeting at 2:00 p.m., and by way of entertainment, a lecture on "Pictures and Movies in the Making," by R. A. Kissack, director of visual education, University of Minnesota, at 8:00 p.m.

COLLEGE DIVISION DAY

Assembled in one group at 8:30 Monday morning, June 19, the College Division and others present will hear an address by Dr. E. M. Freeman, dean of the College of Agriculture, forestry, and home economics, University of Minnesota; a paper on extension work in agricultural engineering by I. D. Wood; and a report on curriculum accrediting by Dr. J. B. Davidson.

At 10:30 a.m. the Division will split up according to individual interests for separate programs by the research, resident teaching, extension, and student groups. In the afternoon the research and extension groups will hold a joint session, while the resident teaching, and student groups each continue with individual programs.

"University Players" will give a special program in the evening for the entertainment of the A.S.A.E. It will be presented in the Music Building on the main campus of the University of Minnesota.

DIVISION SESSIONS JUNE 20

In the technical division programs the strictly technical engineering element will be balanced and broadened by contributions dealing with biological factors influencing agricultural engineering technology, and with application economics relating engineering developments and equipment use to farm production costs and net incomes.

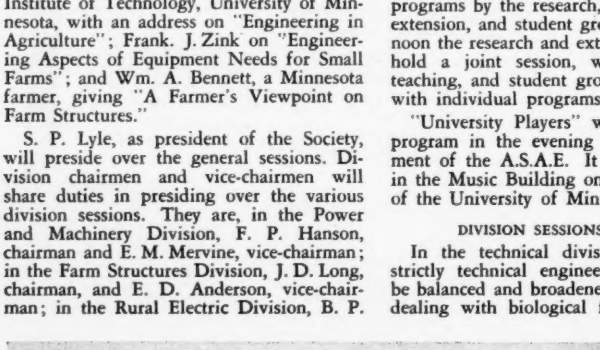
"Fuels for Internal Combustion Engines" is the first subject scheduled for the Power and Machinery Division. E. L. Barger is to report on "Progress Toward a Standard Low-Grade Tractor Fuel." "The Possibilities of Alcohol as an Engine Fuel" will be discussed by Dr. Harry Miller. Committee reports of the Division are also to be presented at this session.

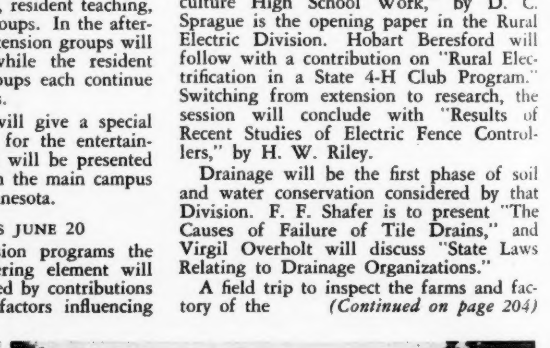
Farm Structures Division attention will be directed first to "Significant Accomplishments and Trends in Farm Structures." Scheduled contributions on this topic include "Fitting Buildings to the Farm," by J. C. Wooley; "More Flexible Farm Buildings," by H. E. Pinches; "Farmer's Interest in Quality Construction," by Carl Widseth; "Rural Lighting," by J. P. Ditchman; "Corn Storage Investigations," by H. J. Barre; "The Milking Parlor for Small Dairy Farms," by K. B. Huff; "Better Silo Construction Methods for Grass Silage," by G. B. Hanson; "Deterioration of Concrete Silos Used for Grass Silage," by Chas. H. Reed; "Laboratory Tests of Concrete and Mortars Exposed to Weak Acids," by D. G. Miller, C. F. Rogers, and P. W. Manson; and "The Algebraic Concept in Land Valuation," by R. C. Miller.

"Rural Electrification in Vocational Agriculture High School Work," by D. C. Sprague is the opening paper in the Rural Electric Division. Hobart Beresford will follow with a contribution on "Rural Electrification in a State 4-H Club Program." Switching from extension to research, the session will conclude with "Results of Recent Studies of Electric Fence Controllers," by H. W. Riley.

Drainage will be the first phase of soil and water conservation considered by that Division. F. F. Shafer is to present "The Causes of Failure of Tile Drains," and Virgil Overholt will discuss "State Laws Relating to Drainage Organizations."

A field trip to inspect the farms and factory of the *(Continued on page 204)*





MINNESOTA SCENES

(Left) The new $500,000 Hydraulic Laboratory of the University of Minnesota, which will be included in the A.S.A.E. inspection trips. This is one of the largest hydraulic laboratories in the world, with a 50-ft maximum head of water, and housing a 200-ft flume 6 ft deep and 9 ft wide, with a capacity of 300 cu ft per second. The model room of the laboratory measures 45x250 ft. (Right) Girls dormitory at University Farm, where some of the A.S.A.E. meeting crowd will be housed

Annual Meeting Program

(Continued from page 202)

Minnesota Valley Canning Company is scheduled for the afternoon of Tuesday, June 20. Special bus transportation will be provided and leave the meeting place at 1:30 p.m. Motion picture entertainment will be offered in the evening.

DIVISION SESSIONS JUNE 21

Wednesday morning June 21 the Farm Structures Division will offer a program on "Biological Reactions of Animals to Environmental Conditions," with contributions by Dr. Samuel Brody, University of Missouri; Dr. Max Kriss, Pennsylvania State College; J. R. Dice, North Dakota Agricultural College; W. M. Regan, University of California; and M. A. R. Kelley.

A symposium on the "Need of Standardization for Electrical Farm and Home Equipment," will occupy the attention of the rural electric group Wednesday morning. Contributors include L. C. Prickett, F. M. Mason, J. S. Webb, and B. D. Moses.

Irrigation is the featured subject on the Wednesday morning program of the Soil and Water Conservation Division. Papers scheduled are "Water Rights for Irrigation in Humid Areas," by Wells A. Hutchins; "Irrigation of Apples in Virginia," by Chas. E. Seitz; "Development of Irrigation Projects in Saskatchewan," by G. N. Denike; "Soil Moisture Control by Irrigation," by R. A. Work; and "Report on Irrigation Terms and Definitions," by J. E. Christiansen.

"New and Special Farm Machinery Developments in North Central United States" will be reported in Wednesday's power and machinery session. R. I. Shawl, E. V. Collins, H. H. Musselman, A. J. Schwantes, E. E. Brackett, H. F. McColly, H. H. DeLong, and F. W. Duffee are to cover developments in their respective states.

Conferences, recreation, and special inspection trips will provide everyone opportunity for activity during the early part of the afternoon. The annual business meeting of the Society is scheduled for 4:30 p.m.

President Lyle has selected L. F. Livingston to be master of ceremonies at the annual dinner of the Society, which will start at 6:30 p.m. The Society's John Deere and Cyrus Hall McCormick gold medals, and the F. E. I. Student Branch Trophy will be awarded at this time, and the new president of the Society, K. J. T. Ekblaw will be inaugurated.

DIVISION SESSIONS JUNE 22

Thursday morning the Rural Electric Division will give attention to a variety of subjects. Those scheduled are "Observations on the Farm Wiring Problem," by J. M. Larson; "Interesting Farm Women in Rural Electrification," by Miss Clara O. Hale, "Load Building through Instructive Publicity," by Frank J. G. Duck; "Electric Fan Ventilation of Dairy Barns and Poultry Houses," by R. W. Louden; and "Report of Survey on Research Work in the Use of Electricity in the Dairy and Poultry Industries," by H. L. Garver.

A joint session of the Soil and Water Conservation and the Power and Machinery Division will open their Thursday morning schedule. "Cost of Power for Irrigation Pumping," by I. D. Wood, and "Snow Ridging for Moisture Conservation," by H. F. McColly are the mutual interest papers to be heard.

Following these papers the two divisions will continue their individual sessions. Additional presentations to be heard by the Soil and Water Conservation Division are "A Hydrologist's Philosophy of Soil Conservation," by W. D. Ellison; "Some Engineering Problems of Migratory Bird Refuges," by S. H. McCrory; "Terracing Costs and Cost Records," by J. T. Copeland; and committee reports on "Designs of Reservoir and Ponds," by C. J. Francis; "Methods of Constructing Reservoirs and Ponds," by D. S. McVicker; and "Planning the Control of Gully Erosion," by J. D. Parsons.

In the balance of the power and machinery session attention will be given to "Observations on Power and Machinery in Industrialized Farm Production," by P. E. Benson, and "The Mechanization of Sugar Beet Production," by E. M. Mervine and S. W. McBirney.

"The Farm House" comes in for attention in the final session of the Farm Structures Division. Presentations scheduled include "Farm Building in Relation to Economic Conditions," by Miss Ruby M. Loper; "Farmhouse Design Problems," by H. E. Wichers; "Farmhouse Design from the National Viewpoint," by James Weston; "Physical Environment and Farm Housing," by J. R. Dodge; "Some Rural Sales Promotion Problems," by Paul Kendall; and "Sanitation of Rural Water Supplies," by Dr. H. A. Whittacre.

Regular annual meeting sessions will close at noon, June 22, but three groups have scheduled post-meeting assemblies the same afternoon to avail themselves of additional time together. They are the agricultural engineering extension group, soil and water conservation group, and rural electrification group.

Deane Carter to be Dean and Director

AGRICULTURAL engineers will be delighted with the announcement that Deane G. Carter, professor and head of the agricultural engineering department at the University of Arkansas, has just been appointed dean of the college of agriculture and director of the agricultural experiment station and of the agricultural extension service at that institution. The appointment becomes effective July 1.

Mr. Carter holds both a bachelor's and a master's degree in agricultural engineering from Iowa State College. On graduation he became associated with the James Manufacturing Company, but later served as instructor in agricultural engineering at Iowa State College and at the University of Missouri, and for one year he was assistant professor in charge of organizing the agricultural engineering department at the North Carolina State College. For two years he operated his own farm in Iowa, and in November 1922 took the position which he now holds as head of the agricultural engineering department at the University of Arkansas.

Mr. Carter was elected to membership in A.S.A.E. in 1916, and in addition to being a former vice-president of the Society and a past-chairman of the Farm Structures Division, he has been one of the more active members on various committees, especially those of the Farm Structures Division. He is one of the outstanding leaders in the field of farm structures.

The news of Mr. Carter's appointment will be received with enthusiasm by agricultural engineers generally, not only because it is a well-earned appointment, but because it also extends recognition to agricultural engineering as a field of work.

Results of College Division Advisory Committee Election

IN the recent election conducted in the College Division of the American Society of Agricultural Engineers, A. W. Clyde, professor of agricultural engineering, Pennsylvania State College, and L. J. Smith, professor of agricultural engineering and head of the department, State College of Washington, were elected to two-year terms on the Advisory Committee of the Division. The Committee for the Society year 1939-40 will, in addition to Mr. Clyde and Mr. Smith, consist of F. W. Duffee, University of Wisconsin (chairman), H. B. Walker, University of California, and D. S. Weaver, North Carolina State College.

North Dakota Establishes 5-Year Curriculum

ACCORDING to word received from H. F. McColly, head of the agricultural engineering department at North Dakota Agricultural College, the College Council of that institution recently authorized a 5-year curriculum in agricultural engineering leading to the degree of bachelor of science conferred by the School of Engineering.

In addition they have also strengthened their major in agricultural engineering, which requires four years and is offered in the School of Agriculture. The 5-year curriculum in the School of Engineering and the major in agricultural engineering in the School of Agriculture are practically the same for the first five quarters.

Statistical Information on Rural Electrification

BECAUSE of the rapid expansion of rural electrification in recent years, certain statistical information has become highly desirable, and the U. S. Bureau of the Census is arranging to obtain some of the more important data in the 1940 Census of Agriculture. An important consideration in connection with obtaining this information was to avoid the discrepancy between the number of farms to which central station electric service is available and the number which are actually using it. Accordingly, a change in the census schedule was proposed, and this change was endorsed by a group of members in the American Society of Agricultural Engineers whose work is practically entirely confined to the field of rural electrification, and was later approved by the Council of the Society. Word has just been received from an A.S.A.E. member, working on this matter that the Special Census Advisory Committee decided to include the question on the availability of electric service essentially as recommended to it in the proposed revision.

The recommended change in the schedule provided two questions, namely, under Item 63, whether or not there was an electric distribution line within 1/4 mile of the farm buildings, and under Item 64, whether or not the dwelling was lighted by electricity. Also provision was included for the person answering the questions to indicate whether the dwelling was lighted by a power line or by a home plant.

(News continued on page 206)

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Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the April issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Jorge H. Rodrigues Arias, instructor, agricultural engineering, University of Puerto Rico, Mayaguez, Puerto Rico. (Mail) Box 623.

J. J. Brickley, assistant superintendent of agriculture, Banes Division, United Fruit Co., Banes, Oriente, Cuba.

Reuben B. Hicks, assistant extension agricultural engineer, rural electrification, Agricultural Extension Service, 1515 W. Cumberland Ave., Knoxville, Tenn.

J. C. Hundley, division agricultural engineer, Tennessee Electric Power Co., Nashville, Tenn.

William A. McWilliams, general manager, Andelot Inc. (Mail) 43 East Division St., Dover, Del.

J. S. Parker, agricultural engineer, Dominion Experimental Station, Swift Current, Saskatchewan, Canada.

J. Frank Relf, associate agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 807 Jefferson St., Stillwater, Okla.

Paul H. Rofkar, RFD 1, Port Clinton, Ohio.

Eugene F. Schneider, manager, corn harvesting machine sales, International Harvester Co. (Mail) 425 Adams St.

Harry H. Steidle, eastern representative, Douglas Fir Plywood Association, 1151 National Press Building, Washington, D. C.

Eyvind B. Wahlgren, graduate student assistant, department of agricultural engineering, Virginia Polytechnic Institute, Blacksburg, Va.

Arthur E. Waterman, architectural engineer, James Manufacturing Co., Fort Atkinson, Wis. (Mail) 425 Adams St.

TRANSFER OF GRADE

Melvin L. Falk, assistant agricultural engineer, Soil Conservation Service, U. S. Department of Agriculture. (Mail) 511 Main St., Clayton, N. M. (Junior Member to Member)

Carl Gragg, assistant chief, migratory labor program, Farm Security Administration. (Mail) 2514 Piedmont Ave., Berkeley, Calif. (Associate to Member)

Student Branch News

SASKATCHEWAN

AT a meeting held at the home of E. A. Hardy on December 4, 1938, an Agricultural Engineering Society of the University of Saskatchewan was formed. Officers elected for the current school year were, A. A. McKinnon, president; C. G. E. Down, vice-president, and R. A. Schmidt, secretary, with J. R. W. Young and J. E. Beamish forming a standing committee. It was decided to start activities as soon as possible after the new year.

A meeting was held on January 10 at which Mr. Hardy was elected honorary president of the Society. At this meeting 12 of the members petitioned to apply for Student Branch Membership in the A.S.A.E.

On January 19, Don Horn of the Dominion Experimental Station at Swift Current, Saskatchewan, gave an address on the results of tests with the newer types of farm machinery at the station. Mr. Horn concluded his talk with the opinion that there would be a definite trend toward the smaller and higher-speed types of farm machinery.

S. F. Shields, project manager of the Eastend Irrigation Project at Eastend, Saskatchewan, presented an illustrated talk. Mr. Shields outlined the work of the Prairie Farm Rehabilitation Act Administration in irrigation development in Saskatchewan and emphasized the future possibilities of this program. At the conclusion of the meeting, members adjourned to the home of Mr. Hardy for lunch and informal discussion.

On February 16, Mr. Bocock of the Cockshutt Implement Co. gave a talk on the latest developments in farm machinery.

In the first week of March, after several executive meetings, a constitution was drawn up. This was presented to the A.S.A.E. and was accepted, whereupon the Society became officially known as the Saskatchewan Student Branch of the A.S.A.E.

On March 9, a meeting was held at the home of Mr. Hardy. Guest speakers included J. MacGregor Smith of the department of agricultural engineering of the University of Alberta and L. B. Thomson and G. N. Denike of the Swift Current Experimental Station. Mr. Smith described the department of agricultural engineering at the University of Alberta. A discussion of irrigation was led by Mr. Denike and Mr. Thomson.

E. E. Eisenhauer, irrigation expert of the Province of Saskatchewan, addressed the members on March 27. The speaker related some of his experiences in the field of irrigation after his graduation, following this with a discussion of the possibilities of irrigation in Saskatchewan. Mr. Eisenhauer then related some of the highlights of his recent trip to Eastern Canada.

The last general meeting of the school year was held on April 4. The first part of the meeting was devoted to business. Officers elected for the coming school year were, R. P. Frey, honorary president; E. A. Hardy, faculty advisor; C. G. E. Downing, president; H. T. Hargrave, vice-president; and H. M. Thompson, secretary, with A. A. McKinnon and J. J. Paterson forming a standing committee. Mr. Hardy then gave a talk on the setup of agricultural engineering in the various colleges in Canada and the United States. Presentation was then made of a set of silver carvers to Mr. and Mrs. Hardy in appreciation of their kindness and generosity to the members of the Branch.

The Saskatchewan Student Branch is quite proud of its distinction as the only A.S.A.E. Student Branch outside of the United States. A good program is promised for the 1939-40 term and the members are enthusiastic about the future of their organization.—*Ronald Schmidt, Secretary.*

TENNESSEE

ACCORDING to a report from David W. Chandler, secretary-treasurer of the new Student Branch of A.S.A.E. at the University of Tennessee, the Branch is planning exhibits and demonstrations to be offered as instructional features of the East Tennessee Farmers Convention to be held at the University in the latter part of May.

One demonstration, on soil conservation, is to be a miniature farm modelled in native clay and showing terraces, strip cropping, contour tillage, gully control, and other conservation measures. Fence-post treating demonstrations, and exhibits of farm machinery and of electric fencing units are also planned.

OHIO

AT THE meeting of March 2, C. A. Norman of the mechanical engineering department gave a talk on "The Application of Engineering to Present-Day Problems."

During the first part of the spring vacation period, 29 members of the Branch took an inspection trip to the TVA near Knoxville, Tennessee. Six automobiles and one motorcycle furnished the transportation for the 29 members and our faculty advisor. We received splendid cooperation from the University of Tennessee and the TVA in making our trip both educational and enjoyable. The major expense for the 1300-mile trip was deferred by earnings of the Student Branch.

Mr. Meyers from the Meyers Hybrid Seed Corn Co., discussed "Hybrid Corn and Corn Planter Plate Problems" before the group on March 30, following the business meeting.

At the regular meeting of April 13 the following men were elected to the 1939-'40 Branch offices: President, Robert Hartsock; vice-president, Harris Gitlin; secretary and treasurer, Edwin Miller; sergeant at arms, Austin Spetka; faculty advisor, R. C. Miller. —*Charles B. Peak, publications committee.*

SASKATCHEWAN STUDENT BRANCH OF A.S.A.E.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers thereof, whose names and addresses may be obtained on request to AGRICULTURAL ENGINEERING, St. Joseph, Michigan

SOIL DEFENSE IN THE SOUTH, *E. M. Rowalt.* U. S. Dept. Agr., Farmers' Bul. 1809 (1938), pp. [4] + 64, figs. 39. This bulletin describes farming practices that conserve soil and indicates how such practices may be applied to farms in a large part of the South. Its scope is limited to that part of the Cotton Belt extending west from the Georgia-Alabama line to central Texas and southern Oklahoma. It is based largely on the soil conservation practices employed by farmers within the various project areas of the Soil Conservation Service in this section of the cotton country.

ELECTRIC DAIRY WATER HEATER AND UTENSIL STERILIZER, *D. G. Ebinger.* Michigan Sta. Quart. Bul., 21 (1938), No. 2, pp. 93-96, figs. 2. A portable combination electric water heater and sterilizer designed by the station is described and illustrated.

TO HOLD THIS SOIL, *R. Lord.* U. S. Dept. Agr., Misc. Pub. 321 (1938), pp. [6] + 122, pls. 39, fig. 1. This is a broad, generally nontechnical treatment of the history, the effects to the present time, and the measures now being taken to control accelerated erosion as caused by water and wind.

THE PHYSIOGRAPHY OF ARIZONA VALLEYS AND THE OCCURRENCE OF GROUNDWATER, *G. E. P. Smith.* Arizona Sta. Tech. Bul. 77 (1938), pp. 41-91, pls. 3, figs. 26. This bulletin describes the physiography of Arizona valleys, including the natural surface features and the character and origin of the underlying valley fill; indicates the location, storage characteristics, and availability of the ground-water supplies in general; and shows the relationship of the physiography to the important supplies.

"Although the topography of the bottom lands, the slopes, and the foothills appears to be accidental and haphazard, it is found on analysis to be definitely regular and understandable. Based on a knowledge of the origin and history of the natural surface features, a great deal can be foretold about the water storage capacity and the safe yield of the underlying formation."

The importance, in relation to the Arizona ground-water law, of a distinction between "percolating" waters and waters "flowing in definite underground channels" is noted, and the basis for such a distinction is provided.

TESTS FOR THE PERMEABILITY OF SOILS, *C. W. Robinson.* Jour. Boston Soc. Civ. Engin. 25 (1938), No. 3, pp. 394-408, figs. 4. The author describes the construction and operation of a soil permeameter arranged for constant heading, for upward as well as for downward flow, and for the insertion of three piezometers opening at different levels into the soil column, together with two additional piezometers, one above and one below the soil column.

"The rate with which a soil will permit water to flow through it is of prime importance in the design of practically all structures in contact with earth. It is of especial importance in the design of earth dams, foundations on more or less plastic soils, retaining walls and cofferdams." It is pointed out that a study of disturbed samples, of which the natural structure has been lost, is justifiable in connection with such constructions, in that "the material in the dam will have little, if any, structural relation to the material in its natural state. The soil under the dam will be much compressed and altered and will differ considerably in structure from what it was previous to the placing of the dam. Therefore, disturbed samples are satisfactory for most purposes in preliminary work at least."

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices published in this bulletin. Requests for insertions should be addressed to ASAE, St. Joseph, Michigan.

POSITIONS OPEN

DESIGNER and layout men familiar with the design of harvester combines wanted by a well-known manufacturer of farm implements. PO-123